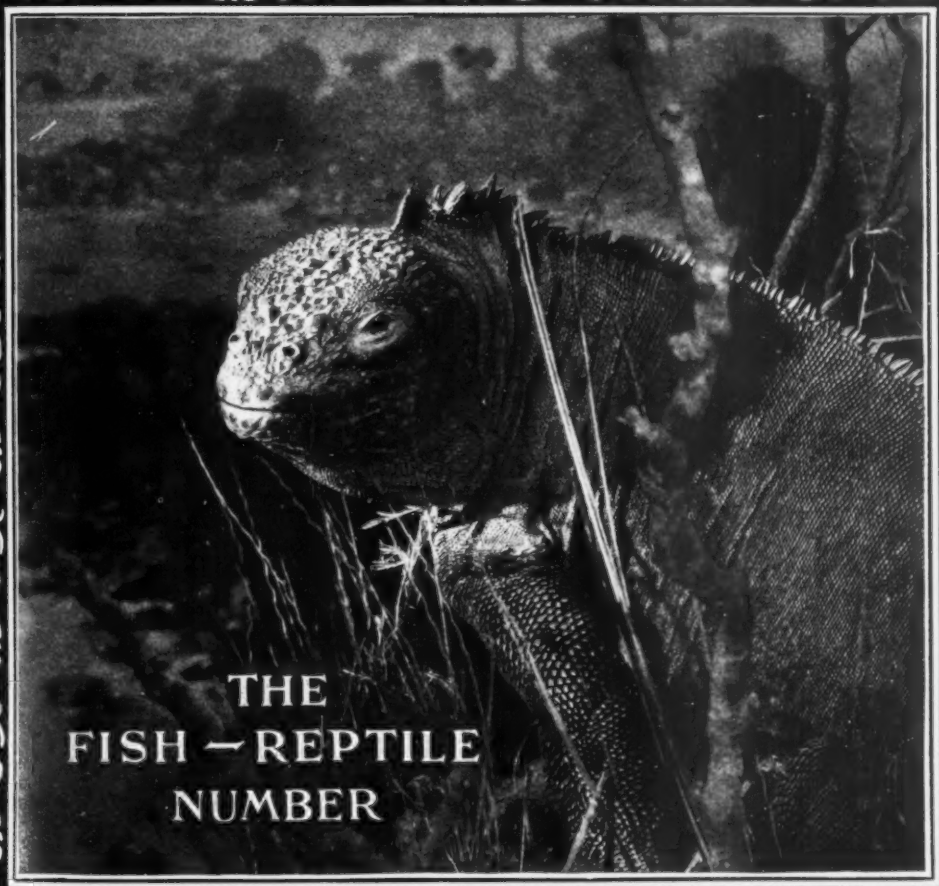
Vol. XXV JULY-AUGUST, 1925 No. 4

NATURAL HISTORY



THE FISH—REPTILE NUMBER

JOURNAL OF THE AMERICAN MUSEUM OF NATURAL HISTORY

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NATURAL HISTORY

THE JOURNAL OF THE AMERICAN MUSEUM

DEVOTED TO NATURAL HISTORY, EXPLORATION, AND THE DEVELOPMENT OF PUBLIC EDUCATION THROUGH THE MUSEUM

FISH—REPTILE NUMBER

EDITORS

EUGENE WILLIS GUDGER, Ph.D., Fishes

G. KINGSLEY NOBLE, Ph.D., Amphibians and Reptiles

JULY–AUGUST, 1925

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NATURAL HISTORY

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The Bird Number

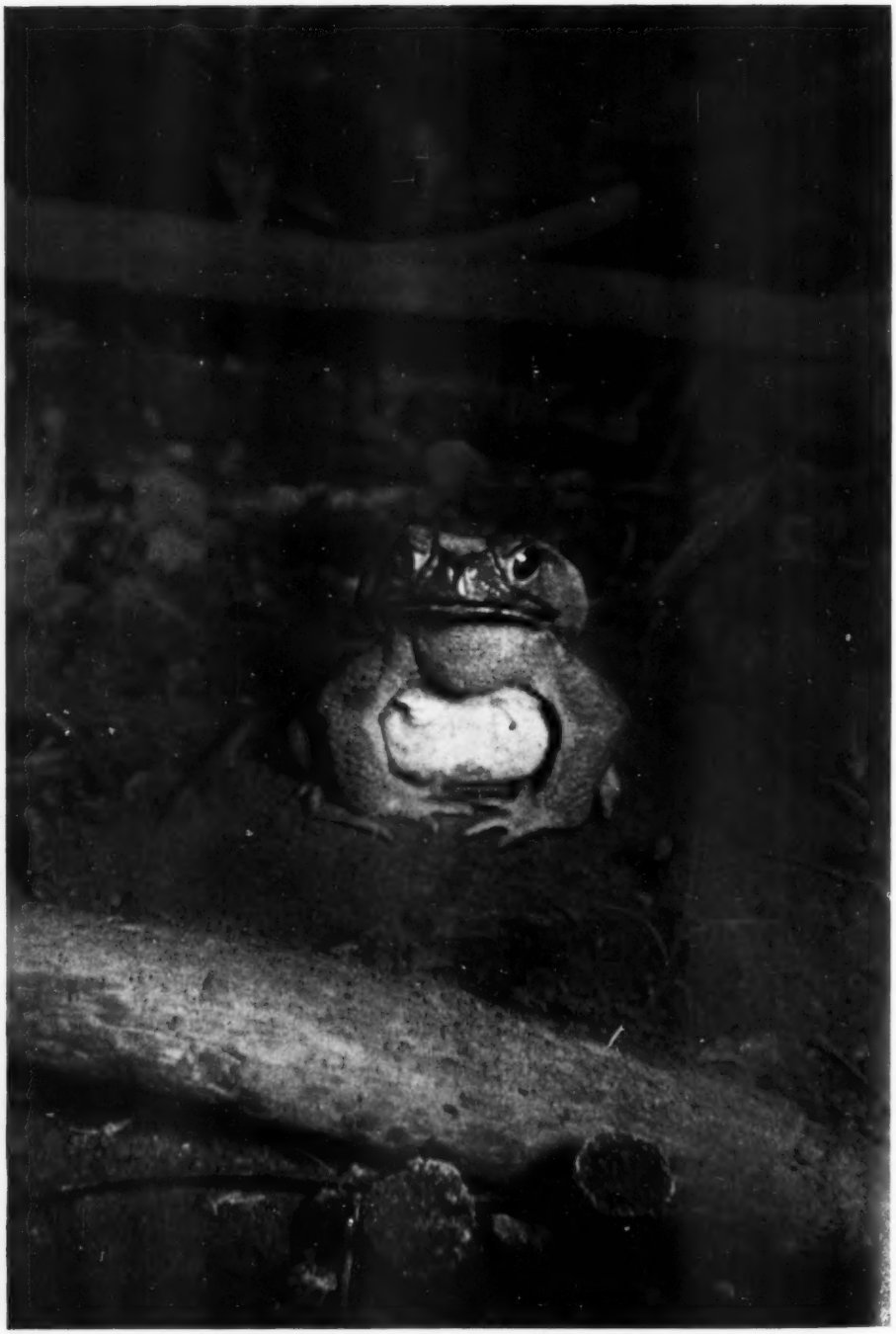
The September-October issue of NATURAL HISTORY will be a "Bird Number" under the editorship of Dr. Frank M. Chapman, curator of the department of birds. This issue has been planned to show what the members of the department have done lately or are doing, both in the field and in the Museum; to report on our expeditions; to present information in regard to the bird life of the New York City region which will be interesting to the general reader and useful to the special student; and to review general activities in the field of ornithology as they are reflected in the work of other museums and in recently published literature.

The leading article will be by Dr. Robert Cushman Murphy, associate curator, who, returning in November, 1924, to the Pacific coast to resume his studies of marine bird life, encountered there climatic phenomena which possessed for him an especial significance. Mr. Waldron DeWitt Miller, associate curator, will write of the birds of a still comparatively wild portion of northwestern New Jersey; while Mr. Ludlow Griscom, assistant curator, will list the surprisingly large numbers of birds which visit Central Park. Dr. James P. Chapin, associate curator, will present some of the results of his studies of birds in the Congo region, and Dr. Frank M. Chapman will take for his subject the European starling, the early history of which in America is intimately associated with the Museum. Illustrating coöperation between Museum departments, as well as the interrelation of their respective fields, Dr. E. W. Gudger of the department of fishes, has contributed an exhaustive article on "Fishing with the Cormorant."

There will be extracts from the letters and reports of Beck in the Fijis, the Olallas in Ecuador, Benson in Panama, Tate in Venezuela, and Boulton in Angola—all tinged with that spirit of adventure which colors the life of the exploring naturalist.

First place under a report on "Additions to Our Collections" will be accorded a pair of the much sought for pink-headed ducks, which we owe to the Vernay-Faunthorpe Expedition. This will be illustrated with a colored plate by Jaques of the Museum staff.

The books reviewed will include Phillips' *Ducks;* Cory and Hellmayr's *Birds of the Americas,* Part III; Mathews' *Birds of Australia;* and Thorburn's *British Birds.* There will also be brief mention of the more important articles in the ornithological magazines.



THE GUARDIAN OF THE TRAIL

The giant toad, *Bufo marinus*, brings us to a halt. In the light of the flash lamps he presents a formidable appearance

NATURAL HISTORY

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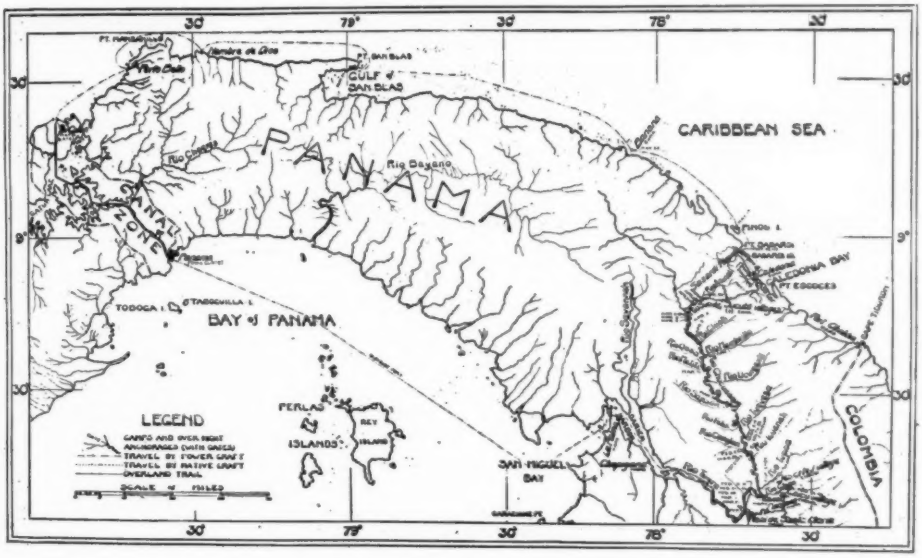


The route of the Marsh Darien Expedition of 1924.—The Rio Chucunaque, where most of the following observations were made, is the large river on the right. The map is based upon data compiled by Mr. R. O. Marsh

In Darien Jungles[1]

EXPERIENCES OF A STUDENT OF REPTILE AND AMPHIBIAN LIFE IN A LITTLE-KNOWN PART OF PANAMA

BY C. M. BREDER, JR.

New York Aquarium

FIELD naturalists are those more or less enviable persons who occasionally have to break away from civilization and plunge into the wilderness, there either to drink their fill of happiness and fresh breezes, or to drain the cup of hardship to the dregs while securing data in regard to some problem of animal or plant life. I was the first in such a rôle ever to have visited that particularly inaccessible part of the Isthmus of Panama drained by the Rio Chucunaque. My problem was to work out the life histories of some of the amphibians and reptiles, to collect fishes, and to determine as far as possible what cold-blooded vertebrates inhabit this remote section of Panama. As a member of the expedition organized by Mr. R. O. Marsh in 1924, I was generously provided by him with all possible facilities while carrying on this work in the interests of the American Museum.

It is not my intention to report here upon the work of this expedition, nor to enumerate in detail the many pleasant and the few unpleasant events which occupied our time. But looking back upon those six months of travel and

[1]Photographs by the author.

Combining new and old methods of transportation.—Outboard motors were attached to native dugouts, making our progress rapid on the lower, open reaches of the Chucunaque. Higher up the river the motors were rendered useless by the low water and river débris

investigation, certain happenings come to mind which may serve as a sample of my own experiences. These events were not always important in themselves, and most took place without the knowledge of my companions. Perhaps some were interesting only because of their setting or associations. My work was carried on largely at night, and the sense of hearing was necessarily relied on more than that of sight. Often I could imagine myself converted into a keen-eared jungle creature slipping quietly through the forests, listening each moment for some new sound to break the stillness.

I remember one particular evening when I settled down just before dusk near the bank of a small stream which flowed into the lower Chucunaque. The short twilight had passed with that abruptness so characteristic of the tropics, and I felt the darkness rushing in upon me from all sides. Harry Johnson, our taxidermist and my companion of the earlier part of the evening, had gone off to run down some unknown howl. While sitting there fascinated by the approaching night, I became aware of a slight rustling in the fallen leaves behind me and thought at first that Johnson was returning. But when the rustling became louder and louder and spread to both the right and left, I realized that there was something unusual about it. There was a peculiar squashy quality in this rustling, quite different from the noises made by the twigs or nuts broken off by monkeys in their arboreal travels. I thought of peccary herds, and knowing that at times they were rather dangerous, I imagined that it might be awkward to be surprised in my exposed position. Seizing my flashlight, I stood up in preparation for what might come. The noise ceased immediately. After some moments of intense silence it began again on all sides of me and this time I did not delay for a moment. The first long flash across the forest floor revealed the sources of these

The field laboratory.—The absence of insect pests and the abundance of amphibian life made camping conditions ideal along the Lower Chucunaque

peculiar sounds. Frogs of all shapes and sizes were beginning to migrate toward the water, literally covering the ground in their jostling haste. There were species of *Rana*, *Bufo*, *Hyla*, *Leptodactylus*, and *Eleutherodactylus* in this hodgepodge of tumbling frogs. Nearer the water I spied the little piping frog, *Phyllobates*, moving in the opposite direction,—away from the streams,—for, as far as my observations go, this species is entirely diurnal. It seemed as though the latter was moving away to make room for the great hordes of nocturnal anurans which had begun their migrations at the fall of night. As I stood and wondered, some of the larger frogs took up appropriate positions and began to call loudly for mates.

Every night, not far from our camp near Yavisa, one cry arose above all the others. This was a tremendous *Whoop!* which sometimes echoed for more than half a mile through the jungle. Finally the voice was traced

to a large, handsomely marked frog, *Leptodactylus pentadactylus*. The individuals of this species spent their days in solitary burrows which, in some cases at least, they doubtlessly dug for themselves under the great rocks in the

Eyes like brilliant rubies mounted in an emerald frame. The handsomest tree frog of the whole region is *Phyllomedusa callidryas*

forest. At night they emerged from their retreats and whooped loudly to one another, apparently calling for mates. In this they were evidently successful, for many egg masses were found beaten into a froth by the parent frogs and laid in contact with small puddles of water under the heavy growth. Frequently these egg masses covered the water entirely, leading me to believe at first that the eggs had been merely laid at the bottom of one of the innumerable depressions in the forest floor. These foamlike formations hardened on the outside into a dry crust. Slim-bodied tadpoles hatched from the egg capsules and swam easily about in the liquefying interior of their foamy incubators. The foam method of egg-laying is obviously a successful adaptation to breeding in a region subjected to alternate cloud bursts and droughts. The first falling of the dashing rain of this country shatters the crust on the nest and washes the little tadpoles rapidly into the open streams where they take up a more venturesome existence. On one occasion I watched the entire process of the release of the tadpoles under the whipping of a terrific storm. Although I tried to shelter myself under a clump of palms, I was soon thoroughly drenched. As the rain ended in its customarily abrupt manner, a light breeze sprang up and the sun burst forth from behind the rapidly disappearing clouds. My clothes acted as a kind of evaporation bag, and before I reached camp my teeth were chattering. Although only 8° from the equator, at little over sea level, I suffered more from cold than I ever have in snow-bound New England.

The result of such a rain after the protracted dry season is considerable. The giant forest trees, burdened down by a load of soaking vegetation, frequently crash to the ground. The weight lies not only in their own structure, but in the great masses of vines or "Bahukas" which struggle upward to form the warp and woof of the canopy completely "roofing" the jungle. The same rain which tore open the frog nursery, brought down a giant tree not sixty feet away. The first warning was a gentle creaking and

cracking as the tree listed to one side under the soft caress of the breeze. Then followed a swishing and grinding, as the great Bahukas writhed back and forth like so many serpents in their death agonies. The great tree hung forward supported by its vines, which gave way one after another until the remaining few could hold on no longer. The former dwelling of innumerable tree frogs, jungle fowl, and monkeys, would now soon become the home of countless hordes of wood-boring insects which would gnaw its great bulk into a labyrinth of rotting pulp.

Silence is frequently more awe-inspiring than sound. It is the silence following upon the fall of the forest giant which is clearer in my memory than the vicious swish and slash of the broken branches. Similarly, it was the silence between the cries of the howler monkeys or the calls of the whooping frogs which tingled my nerves more than the sounds themselves. Some of these silent moments of the jungle are difficult to explain. Many a time while I sat quietly beside some stream bed watching the dozens of frogs pursuing their spawning activities, I thought my ears would split from the deafening chorus of the innumerable unmated males. Then suddenly, without warning, this mighty chorus would stop as if given a signal from the leading chorister. The silence — the tremendous silence— which followed always thrilled me by its magnitude. Some minutes later a timorous peep would arise, then on the other side another frog deigned an answer. Then another and another, until the whole chorus was once more in full voice. Again, without warning, the babel would cease. What caused these silences? Surely, the frogs had not spied me. Could it be something unseen by me that brought their song to such a sudden termination? No such an enemy was ever found, and I must admit that the whole problem is still quite beyond me.

The great lagoon-building frog, *Hyla rosenbergi*. In this daylight portrait the pupil is contracted to a horizontal slit. Compare with the flash-light portraits which follow

The forest along the Chucunaque proved to be a most untrampled wilderness. As recently as 1916 Meek and Hildebrand,[1] who spent considerable time in Darien collecting fishes,

[1]Meek, Seth E., and Hildebrand, Samuel F., "The Fishes of the Fresh Waters of Panama." *Field Mus. Nat. Hist. Pub.* 191, *Zoöl. Series*, Vol. X, No. 15.

THE FOREST NEAR YAVISA
Many nights of field study were devoted to this jungle

EVERY JUNGLE STREAM INVITED EXPLORATION
Such pools as this seldom failed to yield a rich return of amphibian life

A favorite pool of the cooing frog.—The patches of white at the far side of the pool are the foamy nests of the cooing frog, *Eupemphix pustulosus*

Two frog nurseries.—These basins of mud have been constructed by the large tree frog, *Hyla rosenbergi*

dismissed the thought of field work along the Chucunaque with the following brief but expressive statement: "This stream lies almost wholly within the San Blas region. Its exploration was therefore not undertaken." At night this forest offered innumerably more difficulties than during the day, but it was only at night that many of the interesting forest denizens were available for study. It was, therefore, necessary for me to carry on most of my work after the twilight hours, while my companions were resting from their diurnal labors about a pleasant camp. In the light of my headlamp many of these forest creatures took on strange shapes and colors. Crocodiles which during the day had lain gazing stupidly out of their greenish eyes, now turned two red coals of fire toward my flash light. Lizards which had played all day in the sunlight were now flattened out against the branches in sleep. My nightly prowls were easily the most delightful part of the entire trip. There is something indescribably fascinating about the jungle at night. The general quiet broken only by the calls and howls of the nocturnal prowlers or the swish of a bat wing close to the ear, while empty and stupid when described, was incredibly soothing after chasing lizards all day in the baking sun.

One night sound that held my attention from the beginning was a triple knock like three cabalistic blows on the paneled door of a secret lodge. This sound came from one of the drying stream beds some distance from camp. My light, settling upon the edges of the stream, revealed a series of circular mud nests, each built up as a tiny lagoon above the surface of the water. In each with few exceptions there sat a large tan tree frog with the throat distended for calling. In some cases the nests were so close together that their walls touched. The few nests that lacked a guardian tree frog were filled either with spawn or wriggling tadpoles. Many a night I came back to these lagoon nests and tried to increase my knowledge of the habits of these creatures. One night, after I had spent a large part of the evening making the usual observations and records of the nests and their contents, I suddenly saw one of the frogs which had been calling in a near-by nest, turn down stream and continue calling with renewed energy. Another frog was hopping toward him up the middle of the stream. She, for it subsequently proved to be a female, kept advancing until almost at my feet. Then they sat and appraised each other while my flashlight outfit illuminated the forest with its sudden glare. Soon the female resumed her flirtatious stroll. I thought this particular affair had terminated, for another male was calling twenty-five feet away, and she was directing her movements toward him. But the first was not to be outdone, and hopping out of his nest, while I continued to photograph the scene, he called loudly for her to stop. Half way between the two she hesitated and while the first suitor moved around toward the far side of his nest and continued his calling, she suddenly seemed to make up her mind, or perhaps better,—the necessary stimulus was received,—for no sooner had he well begun his call than she hopped back straight into his nest, in spite of the continued vocal efforts of the interloper.

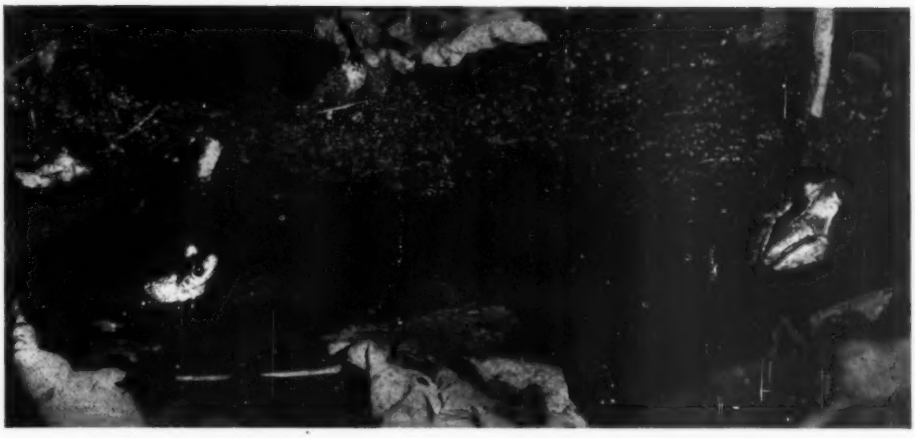
The following day there was a large mass of spawn in this nest that I had been watching. The eggs soon hatched into tadpoles as sturdy and active as the thousands of others in neighboring

A male *Hyla rosenbergi* calling from the mud nest he has constructed. (The first of a series of flash-light studies of a single nest)

nests. Anticipated rains did not arrive, and to my dismay the tiny lagoons began to dry up like the many shallow depressions that they were, exposed to the dryness of the tropical air. I imagined that nature would take care of its millions of little polliwogs struggling in these basins, and I assumed that they would wriggle down into the earth until a passing storm would give them the chance to make their way to the adjacent river. But the storm never came, and these innumerable tadpoles were doomed to death within the tiny clay walls which their father had so carefully, even though mechanically, erected for their welfare. No doubt similar tragedies were happening every day in different parts of this great jungle, but these tadpoles I had claimed for my own, and I could not easily become reconciled to their inevitable fate.

My interests in Darien were not entirely centered upon the frogs and toads for there was work which took me

A female attracted by his voice approaches the nest; the male turns hopefully in her direction and continues to call. The female is in the lower foreground with her head turned toward the male



But another male is calling from another nest. The female moves on toward him while the first starts after her

far afield during the day as well as during the night. In the hot sun of the morning lizards came from their nocturnal retreats, and it was with a view to learning more of the habits of these creatures that I spent most of my daylight hours in the field. One afternoon I came upon perhaps the most famous lizard of Central America, the basilisc, well known for its habit of running swiftly over the surface of the water. There were several young ones together, scampering about in search of insect prey. As I halted to light my companionable old pipe, one of these little fellows, instead of fleeing as usual, came running toward me until it was only about five feet away. From this position it regarded me with what appeared to be considerable curiosity, frequently nodding its head in the peculiar manner of its kind. After the "light" had been secured, the match was naturally tossed to one side. This act deflected the lizard's attention and an immediate short

Rejected, the first male returns to the nest and begins calling for another mate. The vacillating female, changing her mind once more, returns to the first suitor, and enters his nest from the rear

run brought it beside the fallen sliver, which it scrutinized with equal eagerness and lack of fear. Nearly half a box of matches were wasted in amusing this infant lacertilian before I could satisfy its "inquisitiveness." While it was being thus entertained, I shifted

A Chocoi Indian meal.—Sawfish and plantain on the bottom of a dugout canoe

first to a sitting position and finally to a reclining one, while two more basilisks of similar size scampered over from the other side of the creek to see what was going on. These, however, failed to show the lack of fear evinced by the first and were in no way so interesting. From my low position I could not refrain from feeling a certain kinship for the little brute that had showed a curiosity not dissimilar to my own. One of its companions leisurely walked *into* the shallow stream while constantly regarding me from the corner of its eye. It seems odd that these light animals, so adept at racing over the surface of the water, should sink so readily when their speed is sufficiently reduced.

At other times during these brilliant daylight hours, fishes, too, received their share of attention, and sometimes led me into rather embarrassing situations. One species in particular received the attention of even those of us least interested in the lower vertebrates. This was one of the *Sardinas* (*Astyanax ruberrimus*) of our negroes. How well I remember the day of our first swim, when, with the initial plunge into the muddy lower Chucunaque, innumerable nibbles of small sharp teeth began on our, at this time, rather tender skins. Only by violent thrashing about could we keep them off. Later we learned to scorn all but their most violent onslaughts. On a seining party later I stationed a man at either end of my net and proceeded to "swim-out" the fishes from a rather deep hole, the little sharp-toothed fishes no longer being of sufficient significance to prevent me. In a few minutes I had splashed about sufficiently to have driven whatever fish-life may have been in the hole to the waiting net, and ordered it drawn up. Then came a shock. On gazing into the catch of this twenty-foot seine we found that in addition to numerous small fish, I had driven into the net a three-foot sawfish (*Pristis microdon*) and a four-foot crocodile (*Crocodylus acutus*). Naturally, thereafter, I was a trifle more discreet. Another time, however, while wading in some clear water to study the swimming movements of a sawfish, a great swish about fifteen feet away revealed that an immense crocodile nearly twenty feet long had attacked the fish and only missed it by a matter of inches. I was

not aware of the crocodilian's presence and apparently it was unaware of mine, —or possibly it did not realize how dangerous I could be at times.

Numerous other adventures, some highly exciting, were encountered by all of us on our eventful journey across the divide. Our experiences with Indians of two very different types, a terrible experience in a stupendous flood in which I nearly lost my life, strange sounds in the night that we never satisfactorily traced, and many other happenings, cannot be gone into here. The loss of two of our comrades, although still fresh and painful in my memory, I feel must be mentioned, if only briefly. Mr. Roaul Brin, representative of the Panama Government, and botanist, became stricken in the early part of the trip by malignant malaria which, together with the cumulative effect of previous attacks, proved too much for his otherwise rugged constitution. He was able to return to Panama City, but too late for medical aid to be of any avail. Professor J. L. Baer, anthropologist of the Smithsonian Institution, my tent mate for most of the time, collapsed under the strain of the trip and repeated insect infections. We were unable to send him back, and hence took him across the divide to the Atlantic coast. He grew steadily weaker. A Navy aëroplane that had been sent for arrived about a half hour too late. He now rests amid a grove of coco palms at Caledonia, a martyr to the cause of science.

Our expedition was one on which we experienced our full share of misfortunes as well as happiness. Although the field into which we penetrated is still scarcely touched, my own work, I am happy to say, has proved a satisfactory beginning. There remains a considerable area covering the low divide between the headwaters of the Chucunaque and the Bayano still unknown, which, with our present knowledge, could be entered with less difficulty than we experienced. It is always with a pang of regret and hope for the future that I scan a chart of these areas we missed by merely a few miles. I hope some day that I may push on from where we left off.

Chocoi Indians spearing fish

XIPHIAS GLADIUS
THE "BROADBILL" SWORDFISH

Photograph by Ernest Windle of the world's record catch with rod and reel—weight 377 lbs. Taken at Avalon, Santa Catalina Island, August 3, 1916, by H. W. Adams, of Vermejo Park, New Mexico. The time required for the capture of this giant mackerel was one hour and fifty minutes

Giant Game Fishes

SWORDFISHES, TUNAS, AND OTHER

By DR. DAVID
Chancellor Emeritus of Leland

THE little port of Avalon on Santa Catalina Island, off the coast of Southern California, is known to all deep-sea anglers the world over. There in the spring and summer the giants of the mackerel tribe gather for their annual feast of flying fishes and sardines. Swiftest of all fishes, wandering far and wide and hunting in packs, these monsters, or some of them, are found along the edge of the tropics in all warm seas. The headlands and channels of Southern Japan, from Izu to the Ryukyu Islands, are alive with them. They also gather about the Hawaiian Islands. Some of them abound in the West Indies, swinging northward in the Gulf Stream. A small minority breed in the Mediterranean, but a chosen summer resort of most of them is found in the Santa Barbara Islands, and at Avalon the sea anglers of the world meet them halfway.

All these fishes are shaped like a clipper ship, some of them (swordfish and spearfish) with a long bowsprit, the rest with noses unarmed but sharp as if whittled to a point. All of them have small, sleek scales, more or less hidden in the skin, and dorsal fins that slip back into a groove. Each has a slim tail with a strong backbone, moved by p werful red muscles and ending in

# of Santa Catalina

MACKEREL-LIKE SPECIES

STARR JORDAN
Stanford Junior University

broad, forked, fan-shaped caudal fin, their means of propulsion through the water.

The species of true mackerel (*Scomber*) are the smallest of this tribe, existing in countless millions, the common mackerel of the Atlantic from an economic point of view outweighing all the rest. The smaller chub mackerels of several different but scarcely distinguishable species swarm on the coasts of all temperate regions. Another tribe now regarded as a distinct family (Cybiidæ) is represented by the Spanish mackerel, so called, perhaps, because it is not found in Spain, a wide-ranging group of many species, all with pale, finely flavored flesh, but none being large enough to come into the range of this paper. It is a singular fact that while but one species allied to the Spanish mackerel occurs in California, and that one most rarely, not less than eight distinct genera (*Thyrsocles*, *Thyrsion*, *Zaphleges*, *Ocystias*, *Tario*, *Auxides*, *Xestias* and *Echarion*) are found in the Miocene deposits in the same region.

Passing by the true mackerels with scant recognition of their economic value, we turn at once to the discussion of their huge relatives.

First of these stands the swordfish (*Xiphias gladius*) known to anglers as the "broadbill," a fish

TETRAPTURUS MITSUKURII
THE "MARLIN" SWORDFISH

From a photograph by Ernest Windle of a specimen taken with rod and reel at Avalon, Santa Catalina Island. The "marlin-spike" fish differs from the "broadbill" in that it has a narrow and rounded "sword," is adorned with transverse white stripes, and has its high dorsal fin long-drawn-out posteriorly

that ranges the whole ocean, never overlooking Avalon. In this species the "sword" is longer and stronger than in any other. As the fish grows up, it absorbs all its teeth, and unlike all others of this race, it has no ventral fins.

The swordfish is a creature of tremendous force, the hardest to manage of all that take the angler's hook. The largest taken at Avalon (337 pounds) was the prize of Mr. H. W. Adams of Vermejo Park, New Mexico.

Fishes of this size cannot be very handily examined and compared in museums, and we have to use photographs. But these, whether taken in the Atlantic or Pacific, show no difference, and there is probably but one living species of *Xiphias*.

The swordfish does not seem wantonly fierce, but there are many records of the thrust of its beak through the bottom of a vessel. One New England fishing boat was attacked twenty times in one season. Ordinarily however, the fish uses this savage weapon mainly to stir up schools of sardines, mackerels, and menhaden, which slip through its toothless mouth into an ample gullet. It may be that it spears whales as described in ancient fish stories, but it cannot devour them, and it probably has no mischievous purpose in opening them up with its sword. There is, however, a very old belief that the swordfish and the thresher shark (*Alopias*) combine to destroy the whale. According to this tradition, "the swordfish pricketh from below," while the long, slim, flail-like body of the thresher, pounds the whale as it rises from the water to shake off its enemies.

Personally I have no faith in this tale. The swordfish cannot be convicted of continued malice and the thresher is one of the gentlest of sharks, with small teeth and a mild disposition.

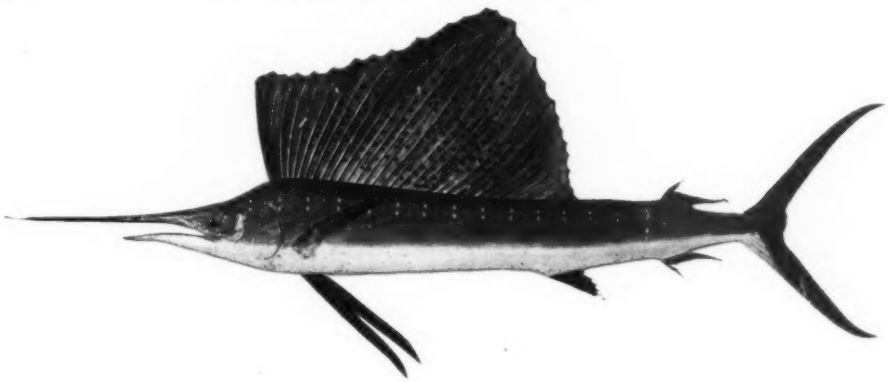
What is mistaken for shark and swordfish is no doubt the great killer, *Orcinus orca*, a giant porpoise, with a high dorsal fin shaped like that of a swordfish. It is of a wolfish disposition and its teeth are long and strong. The killers hunt in packs and are capable of mutilating any whale. They also destroy sea lions and fur seals.

I once saw an attack by killers on a whale off the coast of Lower California. The great animal sprang into the air for almost the length of the body, with one or more killers clinging to its sides, writhing and twisting in its efforts to detach these marine bulldogs. A skilful photographer, Mr. W. W. Richards, had the fortune to see, off Santa Cruz in California, a fracas of the kind. He made of it a picture, probably absolutely unique, which I have reproduced in *Days of a Man*. Around the suffering whale, attracted by the blood, are multitudes of greedy shearwaters (*Puffinus*) known as "whale birds," clamorous for their share of the spoils.

The nearest relative of the swordfish is the smaller spearfish (*Tetrapturus*) known at Santa Catalina as marlinspike-fish, in Hawaii as *a'u*, and in Japan as *kajiki*. It has ventral fins as well as teeth, thus differing from the true swordfish. Its sword is short, narrow, and sharp, and it may be dangerous. Like the swordfish this creature is dark gray in color, but the body is ornamented by cross-streaks of white or silver gray. The species in California and Japan is known as *Tetrapturus mitsukurii*, but as eight or ten other species have been described in various parts of the world, and as no one has got the different forms together, we do not know whether the California spearfish is different from the European *Tetrapturus belone*, or from others named in the West Indies, India, Chile,

and Japan. In any event all warm seas have at least one species of *Tetrapturus*, and that one extremely active and gamy. The largest one recorded from Avalon, taken in 1917, by Mr. C. G. Conn of Elkhart, Indiana, weighed 339 pounds.

Most striking of the sword bearers is the great sailfish, *Istiophorus gladius*. This is like the spearfish in form, but larger, with an immense dorsal fin, trimmed with sky-blue, which stands up like a huge sail, and, umbrella-like, may be depressed in a deep groove which runs along the back. This sailfish is occasionally taken in the open seas, both Atlantic and Pacific. Anglers get it once in a while off Florida and Cuba, and at times in Hawaii and Japan, but it has never yet appeared in California. As in the other cases, no adequate comparison of specimens has been made, and we do not know whether there is one species of sailfish, or two, or three.



Istiophorus gladius, the sailfish. Photograph of a mounted specimen taken on the coast of Florida by Mr. R. T. French of New York City, and presented to the American Museum by Mrs. French

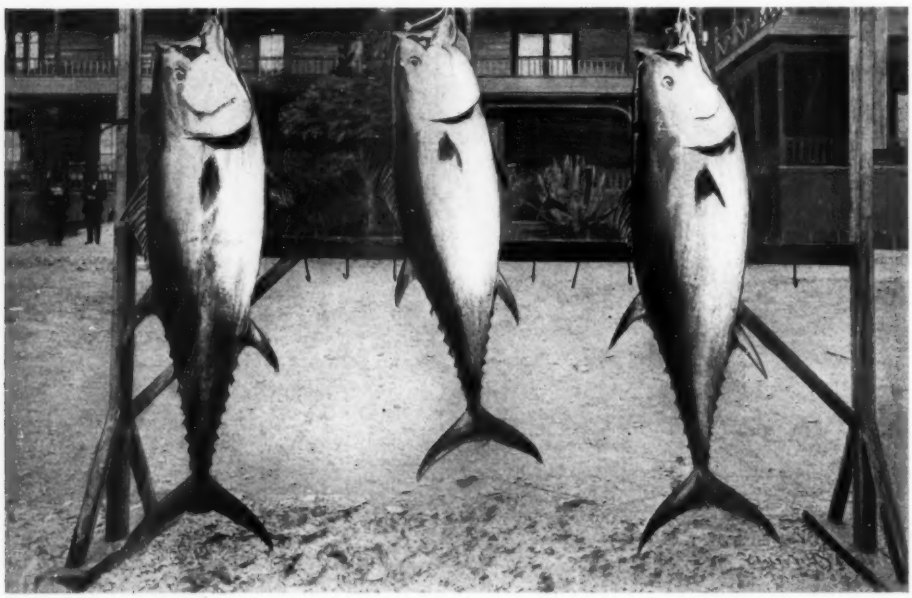
The other giant mackerels of which I shall speak are without swords, but are equally noted for strength and swiftness. The most famous game fish of Santa Catalina is the "leaping tuna" (*Thunnus thynnus*) largest of the family of tunnies or Thunnidæ. These are huge mackerels of the warm seas, capable of swallowing half a dozen of the true mackerels at one gulp. A dogfish weighing eight pounds has been found in the stomach of a tuna. The tuna is known from all related forms by the short pectoral fin, scarcely more than half as long as the head and not reaching nearly to the front of the soft dorsal fin. The color, as in all fishes of this type, is a metallic blue-gray, the young being marked by wavy cross streaks of silver-gray. The fins are colored like the body, hence the great tuna, or tunny, is sometimes called the "blue-fin."

Of all fishes taken on a hook the capture of the tuna requires the greatest skill. At Avalon, this is a form of sport, the acme of angling, but in Japan and in the Mediterranean, where it breeds, tuna fishing has long been a great industry. In Hawaii it is rapidly becoming so, and in Southern California the "tuna canneries" now absorb most of the catch.

I may note here that this particular canning industry began some twenty

years ago with the albacore, the most toothsome of these giant fish. It was put in tins under the name of tuna. The flesh of the albacore is pale, only moderately oily, and of an agreeable taste. That of the tuna is red and coarser and of stronger flavor. But as the canned fish in any case is used mostly as a condiment, for that purpose

ments of their schools are very irregular. They often disappear for years at a time, and then return to their old feeding grounds. I suppose that all of them belong to the same species, *Thunnus thynnus*, although different names have been given to them in different regions and no one yet has made minute comparisons.



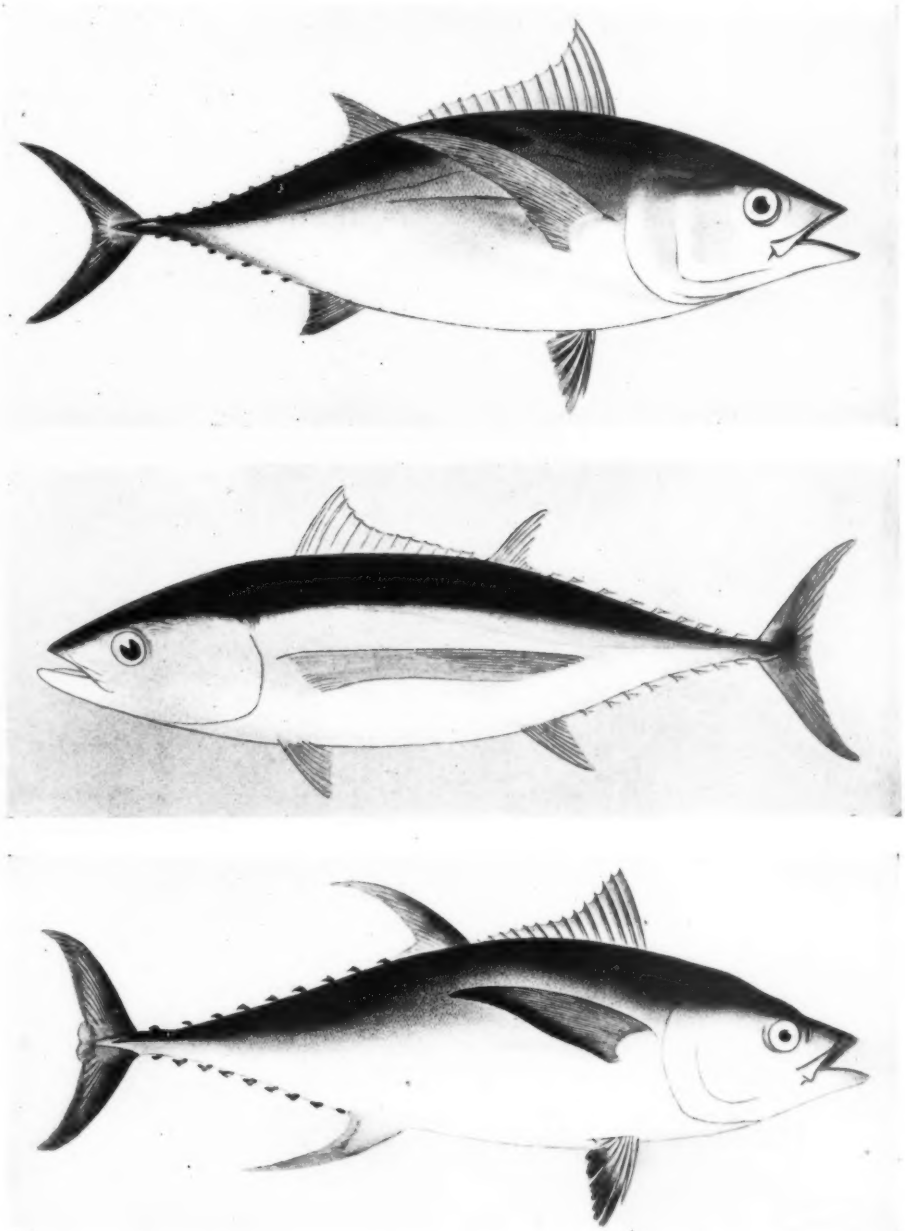
The tuna or tunny, *Thunnus thynnus*. From a photograph of three large specimens taken at Santa Catalina. The pectoral fin of each fish is broken. This fish sometimes attains a weight of 750 lbs

the one is about as good as the other. Later, it has been found that all the tunny family, the tuna, the different albacores and bonitos were alike available for commercial purposes. A large part of the canned tuna of commerce is derived from the oceanic bonito.

The name *tuna* belongs to the south of Europe, but it has been adopted in California. The French name is *thon*, the English, tunny. Great tunnies are found at times in the waters of the Mediterranean, in the Gulf Stream, in Japan, and in Hawaii. The move-

In the Pacific, the largest I have seen weighed about 500 pounds. The maximum record from Japan is 750 pounds. The largest taken by rod and reel at Avalon, according to the careful record kept by Mr. Ernest Windle, weighed 251 pounds, the prize in 1899 of Colonel C. P. Morehouse of Pasadena. When caught, the tuna is said to "leap ten or more feet in the air, presenting a beautiful sight, as the jump is a perfect curve, with no ragged angles."

Smaller than the leaping tuna, but equally interesting, is the albacore,



A group of three giant mackerels. Above, *Neothunnus macropterus*, the yellow-finned albicore. Center, *Germo alalunga*, the long-finned albicore of California, the *tombo-shibi* of Japan. Below, *Parathunnus sibi*, the shibi-albicore common in Japan and Hawaii, but seen only once in California. Upper and lower figures after Temminck and Schlegel, central one after Kishinouye

Germo alalunga, the *tombo-shibi* of Japan. It may be known from other albacores by the absence of yellow on its fins, and from the tuna by its very

long ribbon-like pectoral, which reaches well past the front of the second dorsal. The albacore (not albicore, since its Arabic name Al Bacoro, said to mean a pig, has no relation to *albus*, white) is found wherever the great tuna occurs and in still greater abundance. It has received different scientific names in different regions, but whether the Japanese, Hawaiian, Californian, or other forms differ from the "germon" or "alilonghi" of the Mediterranean, we cannot know without adequate comparison of specimens. The largest albacore taken at Avalon was caught by Mr. Frank Kelley of Goshen, Indiana, in 1912. Its weight was 66¼ pounds.

I once secured in the Santa Barbara Channel an albacore which was a veritable prize package. In its stomach was a big hake (*Merluccius*) recently swallowed. In the stomach of the hake was a fresh example of a deep-sea fish, never seen before nor since. This we called *Sudis ringens*.

Another tuna-like fish found in increasing abundance about Avalon is the yellowfin albacore, *Neothunnus macropterus*, common in Japan, where it is called *kiwada*, and in Hawaii where it is known as *ahi*. It has never been found in the Atlantic. It has the long ribbon-like pectoral of the true albacore, but its dorsal fin is twice as high, yellow in color, and the long array of finlets behind the dorsal and anal are bright lemon-yellow. In size, gaminess, and food qualities, this handsome fish is much like the albacore.

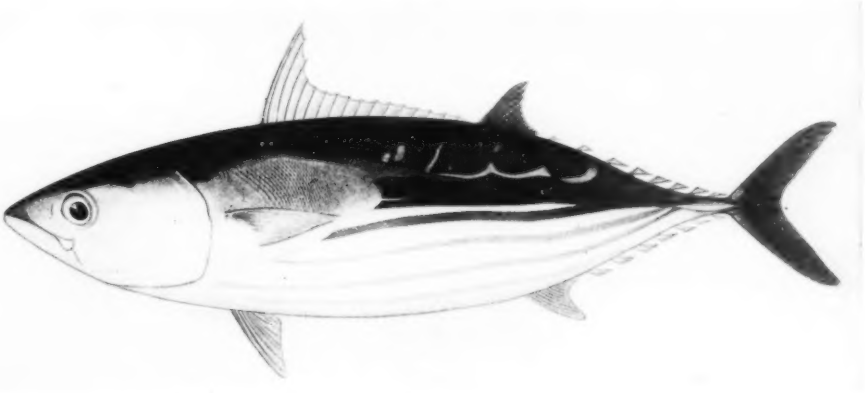
Still another fish of this type is the shibi-albacore, *Parathunnus sibi*. In this species, the dorsal fin is not much elevated, and the finlets are dull yellow, edged with black and whitish. While it is common in Hawaii and also in Japan, where it is known as *shibi*, or *mebachi* (wasp-eye), it has been but once noted in California, and never in the Atlantic.

Omitting all notice of the Atlantic bonito, *Sarda sarda*, and of its Pacific twin, *Sarda chilensis*, as well as of several smaller members of this group, I need mention but one more species, the oceanic bonito (*Katsuwonus pelamys*), the *aku* of Hawaii, *atu* of the South Seas, and *katsuwo* or "victor-fish" of Japan. Like the tuna and the albacore, this is found in the open seas of both oceans, and at times in incredible numbers. It rarely weighs more than eight or ten pounds, and its distinguishing mark is the presence of four long, wavy black stripes on each side of the white belly.

The oceanic bonito is coarser in flesh than its larger relatives, and is canned in an increasing amount in California and in Hawaii, where the demand for fresh fish absorbs all the better species, leaving the *aku* to the canneries.

All the fishes I have mentioned in this paper cast their spawn in the open sea, hence we seldom see the young near the shore. They come usually in schools to feed on flying fish, sardines, anchovies, and other helpless forms. In Hawaii great quantities of a small anchovy called *nehu* (*Anchoviella purpurea*) are netted and thrown into the sea to attract the *aku*. The *aku* in turn is cut into pieces as bait for tunnies and albacore. The oceanic bonito or *aku* runs in prodigious schools. I have a record, from a credible source, of a procession ninety-six miles long of these fishes passing the Hawaiian Islands.

The method of reproduction in all of them has a suggestion of the order which pervades all things large and small in the domain of nature. Each of the millions of egg cells cast off by



Katsuwonus pelamys, the oceanic bonito, the "victor-fish" of Japan, the most beautiful of the mackerels considered in this article. After Kishinouye

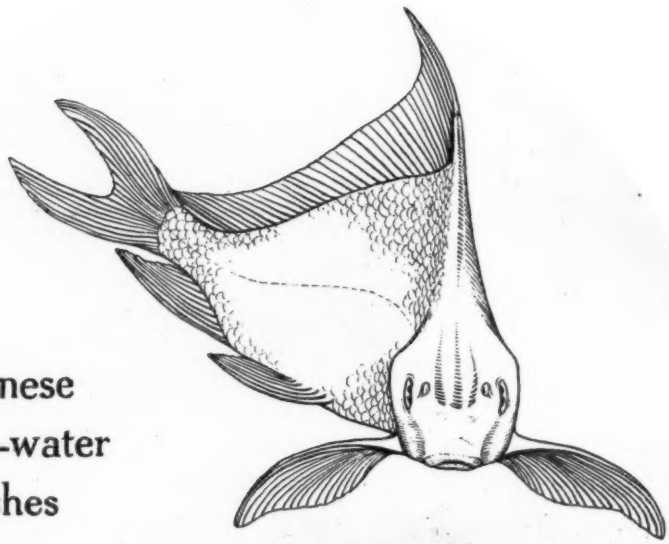
the female *aku* in their migrations contains the minute hereditary elements or chromosomes within the nucleus, together with a bit of food yolk to nourish the young fish should the egg be hatched. Such also is the essential structure of each of the billions of male or sperm cells. Without yolks, microscopic, moving about for a time in the water by a rudderlike tail, all those which do not enter a female cell die, wasted, like the wind-blown pollen of the pine.

Each one of these cells, male or female, when cast off is a half cell, carrying but half the chromosomes of a completed cell, and forming a living being only when the two halves come together, mingling their chromosomes or heredity-content. Within each cell, the chromosomes bear all the inborn tendencies of the race. As the fertilized cell subdivides, the new cells produced from its division range themselves to provide a body with gills and fins and the various other organs of a fish. As the fishlike form progresses, it acquires the thin scales, the two rows of finlets together with all other mackerel-like details. Later on come the characters of the genus *Katsuwonus*, the most notable being a trellise-like modification of the lower side of each vertebra. Then come the surface marks, the four long, curved black stripes of this particular species. These traits the young fish will never fail to secure, for they are carried equally by the chromosomes of egg and sperm, neither of which ever matures unless joined in the sea by a wandering cell of the other sex and of this same species.

Yet no two germ cells, in theory at least, were ever quite alike, and thus as each fish has two parents, again not quite alike, there is endless minor variation in each completed fish. This variation runs in narrow channels in the oceanic bonito for in the sea the range of its schools meets with few obstructions, and the process of natural selection is about the same in one place as another.

Yet with every animal or plant or man the same amazing process in one way or another must take place. No man could have thought out its details in advance, nor yet hopefully guessed at them. Only through instruments of precision could we ever have found them out, and when found out the whole matter of heredity is still enveloped in mysteries more inscrutable and more profound.

Chinese Fresh-water Fishes



SOME INTERESTING FORMS FROM THE COLLECTIONS OF THE THIRD ASIATIC EXPEDITION

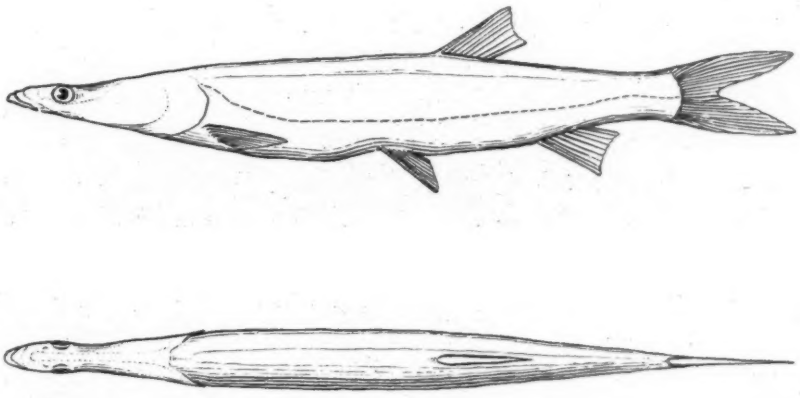
By JOHN TREADWELL NICHOLS
Associate Curator of Recent Fishes, American Museum

THE American Museum's Third Asiatic Expedition has brought together an extensive collection of Chinese fresh-water fishes which are proving of much interest. These were obtained in large part by Mr. Clifford H. Pope at various points. Mr. Harry R. Caldwell, working in the province of Fukien, is also to be credited with a considerable part of the collection, which, taken altogether, is probably the most comprehensive series of Chinese fresh-water fishes an ichthyologist has ever had the good fortune to examine at one time. It comprises upward of 200 species.

The carp family dominates the fish life of Chinese fresh waters. Nowhere else are there so many peculiar divergent carps. In this connection one with a very broad fat head, which attains a large size and is extensively cultivated in ponds for food, may be mentioned. It is known as *Hypophthalmichthys*, and has the eye placed below the central axis of the head instead of more or less above the same, as in almost all fishes. Another peculiar form, *Luciobrama*, has the forepart of the head long and narrowed, ending in a small oblique mouth. This suggests the condition which is carried to a greater extreme in certain marine forms, notably the pipe and trumpet fishes, but it is none the less surprising to find it in a fresh-water species, particularly one belonging to the familiar conservative carp family. Competition is keener on the seacoast and there is more diversity of fish life to be expected there. In *Luciobrama* the whole front of the head is lengthened, not merely the snout as in these marine forms. Its eye consequently is far forward.

Certain predacious carps are of particular interest because of changes which their mouth parts have undergone to fit them for habits to which the carp

family in general is ill adapted. Carps have no teeth in the jaws and ordinarily do not seize living prey of any considerable size. They have small teeth on the pharyngeal bones of the throat, which teeth may be slender and slightly hooked, or blunt and molar as in the carp itself, *Cyprinus*, a gross vegetable feeder. *Opsariichthys*, a very common fish in eastern China, Japan, etc., has a pointed knob on each side of the lower jaw fitting into a reëntrance in the upper jaw, thus simulating a canine tooth. *Scombrocypris* of the Yangtze is a slender predacious species with long, firm, and peculiar jaws, suggesting the mouth of a mackerel.



Luciobrama macrocephalus. This peculiar carp was collected by Mr. Clifford H. Pope at Tungting Lake, close to the Yangtze River in central China

There can be little doubt that the existence of such peculiar, predacious carps in China is correlated with the isolation of that region, for a long period of time, from northern waters where predacious species of other families, the trout and the pike, are the rule. Probably the barrier has been, as it appears to be today, the Gobi Desert. Members of our Asiatic Expedition sent in a few specimens from a stream near Urga, north of the desert, and the two species represented in this lot were both Salmonidæ (trout family). The present barrier area is widened by the nature of the Yellow River, so charged with silt as to be suitable for comparatively few species.

Various types of carps, though not exclusively Chinese or east Asiatic, occur in China in a profusion elsewhere unknown. Such is the subfamily Rhodeinæ, small deep-bodied (flat) fishes with peculiar spawning habits. There is a European species of this subfamily, which lays its eggs in the mantle cavity of the fresh-water mussel, the female fish having a long external ovipositor for that purpose. Another group, the gudgeons, includes a species which is generally common in Europe, a bottom fish with eye placed rather high, and an inferior mouth with a conspicuous single barbel in the corner. In the Yangtze River more or less related forms occur in such numbers and diversity that several well-marked genera are recognized, the commonest of which, when adequately studied, will doubtless

be found to include many species. This subfamily of gudgeons forms an important factor of the fish fauna in the Orient, dwindling to the southward, where it meets an abundance of forms more nearly related to the carps proper and with Indian affinities.

No matter whence it originally came, the carp family has been in central China for so long a time and is there so highly diversified that one is justified in assuming that the Yangtze valley is its center of distribution. A comparatively small number of types of carps occur in Europe, and each type has few representatives.

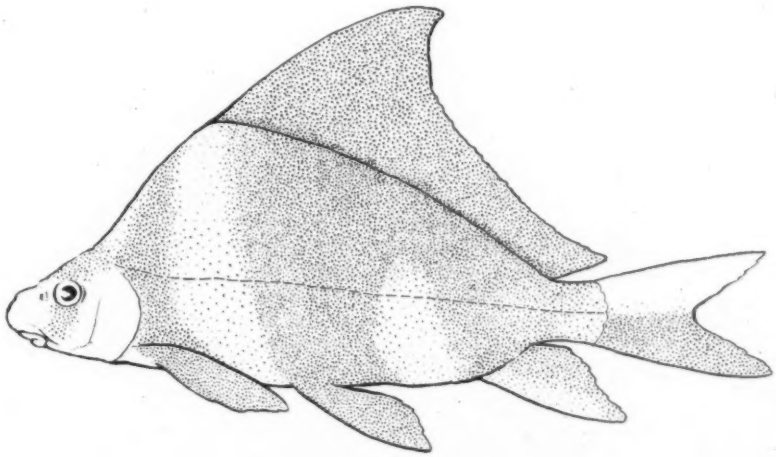
This condition fits the hypothesis that European forms came from the Orient, bearing in mind the distances and obstacles to be overcome in such a journey. Still fewer types have gotten into America by the Bering Sea route, though North American carps present an abundance of species, which have been separated into closely allied genera. Compared to China, America is peculiarly rich in small minnow-like forms, which provide excellent food for the abundant North American trouts, pikes, and percoids (perchlike fishes). This suggests that in the struggle for survival destruction may sometimes be more easily met than competition. It is also interesting that a minnow-like type particularly abundant and widely distributed north from central China, crossing the muddy Yellow River by frequenting its small clear tributaries, is very close to and has been identified with an American genus, *Phoxinus*. It is not impossible that some fish of this sort may be ancestral to various American minnows.

The fishes of Asiatic Russia and its boundaries have recently been rather thoroughly investigated and many of them figured by Dr. L. V. Berg of Petrograd. This author recognizes a northern zone of fresh-water fish life equivalent to the Arctagæa of Huxley. Its southern boundary in eastern Asia is marked by the Gobi Desert and by the Amur River section of Manchuria. China lies outside this northern region, although Chinese and northern types mingle in the basin of the Amur. According to Berg's faunal divisions, a comparatively homogeneous fresh-water fish life extends from Europe across Asia into northern America past Bering Strait, and south over the United States to the Gulf of Mexico, but the very short distance across the Gobi to China results in the distribution of dissimilar fishes.

The occurrence in Asia of the ganoid fishes *Psephurus* and *Pseudoscaphirhynchus*, representing *Polyodon* and *Scaphirhynchus* of the Mississippi River, may be taken as emphasizing the relationship of Asia to America. A peculiarly interrupted distribution of such ancient types, however, appears to the writer to have very little bearing on the way one delimits present-day faunal areas. They are relics of a bygone order in fish life, when they and their associates must have been uniformly distributed. Whether they have survived today in a single restricted locality or two such localities on opposite sides of the world seems but a matter of chance. Much more modern and, *a priori*, with more present-day significance, should be the distribution of the subfamily of suckers, bottom-feeding carplike fishes wherein the pharyngeal teeth are numerous like those of a comb instead of being in restricted number. The suckers are almost exclusively American. They are certainly an offshoot of the carps proper and, as such, should have originated in Asia in line with our hypoth-

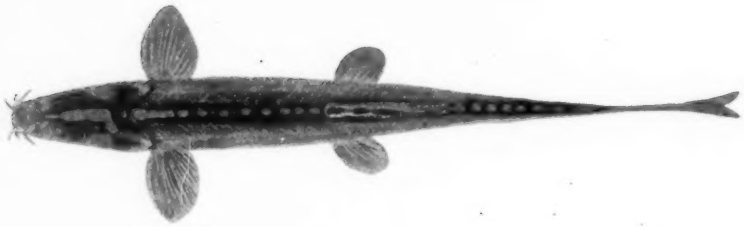
esis of carp distribution. Carps which were able to invade America have been comparatively little differentiated and specialized as a whole since reaching there.

Interestingly enough, the single sucker, *Myxocyprinus*, found outside of America (with the exception of an Arctic species on both sides of Bering Strait) still occurs in central China, the center of the carp family's abundance and variety. It was earlier united generically with highly specialized forms of America's secondary carp center, the lower Mississippi, but as the theoretical probability of any such specialized cyprinoid having crossed to America is small, the present-day view that the resemblance here is a parallelism seems most rational. The suckers have run their course in China, have left but this single peculiar representative behind, and have been superseded more or less by the present-day gudgeons. In America the group is still young.



Myxocyprinus asiaticus resembles but probably is not closely related to certain suckers of our Mississippi Valley. It is the only known member of the sucker group occurring in China, where it is widely distributed though nowhere common. See also headpiece.

Another family of fishes which is abundant and varied in China is the loaches—unquestionably derived from the carps. In fact there still exists in China one very peculiar genus, *Gobiobotia*, sometimes relegated to one, sometimes to the other family. It is loachlike in having its air bladder inclosed in a bony capsule, and in having three pairs of barbels on the lower jaw, as well as one on the upper, whereas in carps two pairs at most are present, one at the center and one near the end of the upper jaw. In other respects, it looks like a carp of the gudgeon group. Loaches might be described as degenerate carps. Their scales are small or wanting, and they frequently are eellike or have a peculiar erectile defensive spine beneath the eye. Evidence points to their being a comparatively recent offshoot of the carps. Otherwise it is reasonable to suppose that they would have reached America, where none are present. Some of the more or less specialized loaches are confined to China. On the other hand, the genus *Barbatula*, of variable and

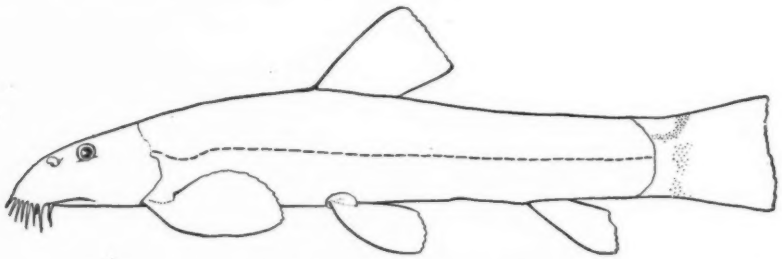


Botia citrauratea, an orange-colored loach. Photograph of a color sketch made in the field from the type of this new species

highly adaptable species, is exceedingly abundant in the highlands of central Asia, and has one species at least which has penetrated to Europe. Given the opportunity, it should have crossed a Bering Strait land-bridge as readily as any carplike fish known to us.

Mr. Pope, while collecting at Tungting Lake, in Hainan, and elsewhere, was accompanied by a Chinese artist (Mr. Wang) who made color sketches from life of various fishes obtained. It is hoped that these will be reproduced at some future date. The life colors of fishes, usually lost at death, are frequently bright and as attractive as those of any other group of animals. Species that swim actively about in the water are more brilliant in coloring. On the other hand most of the loaches, eel-like or bottom forms, have colors of a neutral tone, though often prettily mottled. Specialized loaches of the genus *Botia* are more actively free-swimming, to judge from their trim forms and forked caudal fins, and therefore tend to be highly colored and boldly patterned, so that coloring here becomes very helpful in differentiating the species. Two previously unknown forms taken at Tungting, have been respectively named *purpurea* (purple) and *citrauratea* (orange). The former has a bold dark cross pattern on a delicately purplish ground; the latter is suffused with a strong rich orange, marked off and intensified in spots along the back by dark shading. As fishes of this genus are armed with a sharp erectile spine on each side of the head below the eye, their colors may also have something of a warning significance.

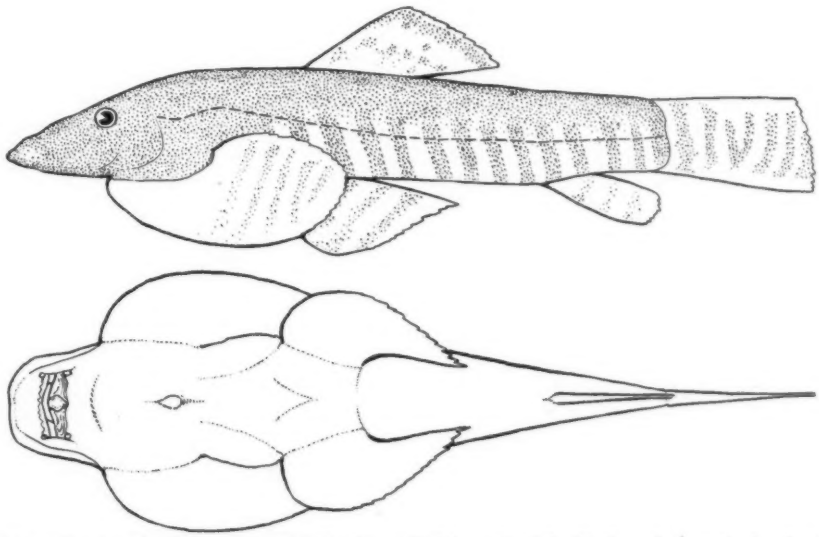
One of the best marked genera of loaches, namely *Crossostoma*, was described almost a half century ago by the French ichthyologist, Sauvage, but



Crossostoma davidi, a loach with a fringe of thirteen barbels hanging from the snout in front of the mouth. Loaches have an indefinite number of barbels, as compared with two pairs at most possessed by members of the carp family, but this little-known species is particularly be-whiskered

has been seldom seen since. It gives us pleasure to figure a specimen obtained in Fukien province by Mr. Caldwell. If the loaches are too recent to have crossed to America, their evolution (or devolution) has been exceedingly rapid, especially

Due beyond question to the Gobi Desert barrier, the important interfaunal line in eastern Asia for freshwater fishes occurs well north of the Yangtze, and it is logical and convenient in considering them to limit one's Chinese area to China proper,



Hemimyzon zebroidus, a new loach from Fukien, short-bodied and peculiarly flattened. In body form and appearance it resembles the more specialized genus *Gastromyzon*, but in technical characters it is closer to the parent form, *Homaloptera*

southward, giving rise to what is at least a distinct subfamily of peculiar specialized forms with flat breast and rounded pectoral fins extended in a horizontal plane. These, known as the Homalopterinæ, are well represented in China but are particularly characteristic of the Indian region and East Indian Islands. One of the most peculiar, specialized genera is the short-bodied *Gastromyzon* flattened for clinging to the rocks. It was previously known from certain of the East Indies, but we have a new species from Hainan Island, and also from the province of Fukien, the second known representative of the genus *Hemimyzon*, which later forms a transition between *Gastromyzon* and its allies.

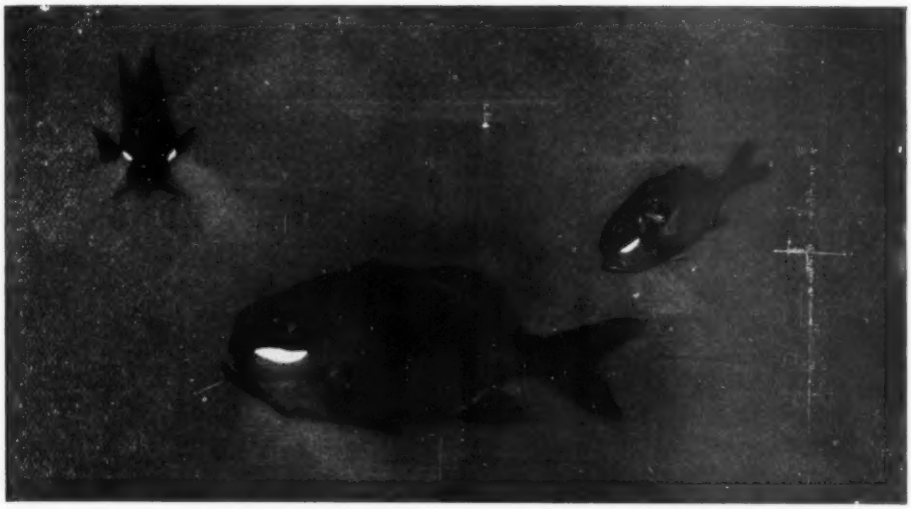
excluding Mongolia. To the south, the central Chinese fauna gradually merges with or gives place to the more tropical Indian one, but nowhere does there seem to be an abrupt change. There should be a theoretical line of demarcation, based on climate, in the neighborhood of the Tropic of Cancer, and a secondary division probably can be drawn in that general latitude to advantage. Thus, though there has been much systematic work upon the fishes of central China, and there is a very large scattered literature on the subject, we have felt confident in describing as new species, a large proportion of the collection which Mr. Pope obtained in the Island of Hainan south of the tropic. They were mostly close-

ly related to forms already known from China and, in some cases, to East Indian forms. A few were southern representatives of Chinese fishes, which had already been described from Tonkin; and a better knowledge of the fishes of that area will probably show the fish life of Hainan to be rather closely related to it.

In the light of present knowledge it is convenient to bound our Chinese area on the south as on the north, by the limits of China proper. So also on the west. The fishes of high central Asia are very different from those of China. A few peculiar types are represented by a great variety of species. These types enter the western provinces rather freely, they are also found here and there farther into China and they are comparatively few in species even in Szechuan, where the fishes of the larger rivers at least are rather typically central Chinese.

From the point of view of the sportsman, the possibilities of Chinese freshwater fishes are as yet little known. A correspondent, Mr. Robert P. Sanderson of Tien-tsin, writes of a giant carp, *Elopichthys dauricus*, locally called *huang-dzuan* or the "yellow screw," which is taken in north China in winter. He has seen fish of this species from Nanking weighing up to 92 pounds. Mr. Sanderson has also angled for the Japanese bass, *Lateolabrax japonicus*, and to his courtesy we owe photographs of this latter fish, one of which is here reproduced, showing Mr. Sanderson and his catch.

Lateolabrax japonicus, a large Japanese bass taken by Mr. R. P. Sanderson at Pei-Tai-Ho, June 29, 1918. It weighed 16½ pounds, with a length of 39¾ inches and a girth of 18½ inches. This species, which is related to our striped sea bass, is found in China and Japan probably running in both fresh and salt water as our striped sea bass does. It is spotted somewhat like the southern weakfish or sea trout.



Three individuals of the luminous fish, *Photoblepharon*, are here shown with the luminous organ exposed. The light due to luminous bacteria is continuous and not under the control of the fish. There is, however, a curtain of black pigment which it can pull up, thus shutting off the light. This organ, being luminous even when removed from the fish, is used by the Banda Islanders as bait for fishing at night. After Dahlgren.

Luminous Fishes of the Banda Sea

By E. NEWTON HARVEY

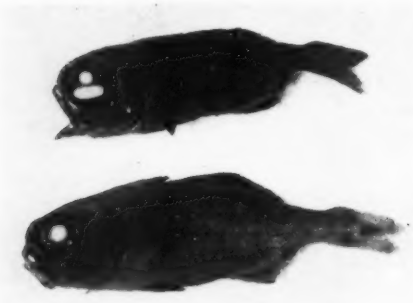
Professor of Physiology, Princeton University

EVERY naturalist is familiar with plants or animals which seem to have become completely isolated from all their relatives, both phylogenetically and geographically. Thus we have the duckbill of Queensland with close relationships to no known creature; or the dodo, now extinct, of Reunion Island; or, in our country, the Venus's-flytrap of the Carolina savannahs. One wonders what the factors can have been to bring about so limited a geographical distribution, for often these forms are endowed with unusual structures that one might conceive would place them in a rather favorable position in the evolutionary struggle.

In the East Indies occur two fish, *Photoblepharon* and *Anomalops* which are remarkable in many respects. I had the opportunity of studying them in the fall of 1920 under the auspices of the Department of Marine Biology, Carnegie Institution of Washington. *Photoblepharon* is found only in the Banda Islands in the very middle of the archipelago. *Anomalops* is abundant at Banda, but has occasionally been taken in Celebes, Fiji, New Hebrides, the Paumotus, and Porto Rico. As the names indicate (*Photoblepharon* = light eyelid, and *Anomalops* = irregular eye), and the figures show, there is a large white organ just under the eye of each fish. It is not always visible, for the fish are able to conceal it at will, and different methods of concealment are used in the two cases. We now know that it is a luminous organ and produces light, but the earlier views of its function, arrived at merely by inspection of preserved material, were indeed fantastic. Some thought that it was to protect the eyes of the fish from injury

by the branches of the coral among which the fish lived, while others thought it a protection of some delicate tissue against the rays of the tropical sun.

Photoblepharon palpebratus with light organ exposed (lower figure), and closed (upper)



Anomalops katoptron with light organ exposed (upper fish), and closed (lower)

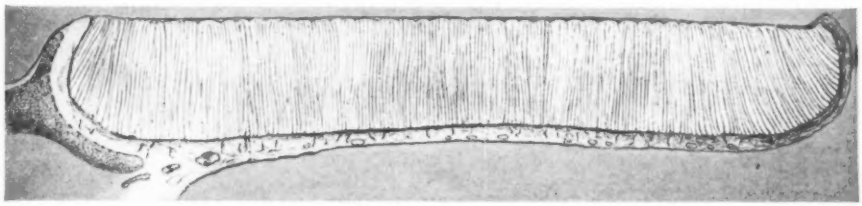
Any native could have revealed its function, for the Banda islanders cut out this phosphorescent organ, attach it to a hook, and use it for bait in fishing. The light lasts for seven or eight hours. So useful has this method become that I found it necessary to pay fairly high prices for enough material for my scientific work.

The Banda Islands rise from the Banda Sea, a very small volcanic group, whose peak, Gunong Api, has been active during the past century. The harbor of Banda Neira is almost completely landlocked and formed an excellent anchorage for Dutch vessels in the halcyon days of the spice trade. For Banda was once a prosperous place where wealthy Dutch merchants exported nutmegs to all the world. It still is a nutmeg center and old villas still remain, but they are empty and the air is one of isolation, of peace and quiet and decay. Ganong Api stands, a lonely sentinel, now dead and calm, meditating on the stir and bustle of the past, and even resenting somewhat the bimonthly arrival of the little Dutch mail steamer that connects these parts with the central government in Java. Amid these surroundings the fishermen have been catching *Photoblepharon* for no one knows how long.

The coastal waters are rich with corals but the bottom suddenly drops off to depths of 12,000 feet. However, these fish are not deep-sea forms. *Photoblepharon* swims alone or a few will swim together among the stones and corals. Hence the native name, *ikan* (fish) *leweri* (?) *batu* (stone). *Anomalops* swims in schools of a hundred or more at the surface but in somewhat deeper water. Hence the native name, *ikan leweri laut* (sea). Both fish are from 8 to 11 cm. in length, but my friend, Sech Ahmed bin Said Baadilla, who acted as my interpreter, told me of an *Anomalops* 25 cm. long.

It is a most extraordinary sight to watch these fish swimming through the water, turning their lights now on and now off, like great marine fireflies. The actual light production is continuous, and in this respect they differ from most animals, which flash only on stimu-

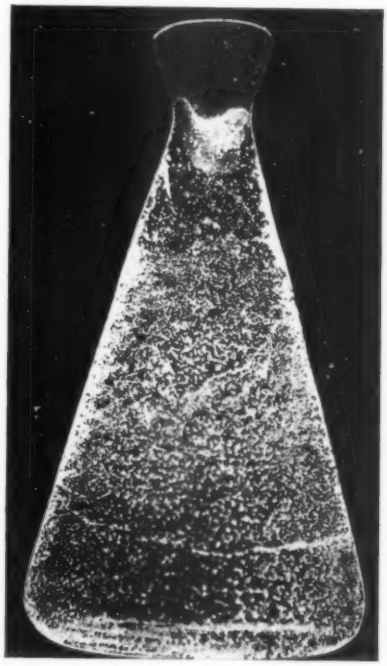
lation, but the organs can be screened. Two totally different methods of screening are employed in the two genera. *Photoblepharon* has a fold of black tissue on the lower surface, which can be drawn up over the organ like an eyelid, completely obscuring the light. In *Anomalops* the organ is attached at the antero-dorsal corner by a hinge which allows the whole organ to be turned over downward into a groove or pocket that completely obscures the light. Why two such closely allied genera, similar in other respects and almost exactly alike in the general structure of the light organ, should have developed such totally different mechanisms for obscuring the light is a great mystery.



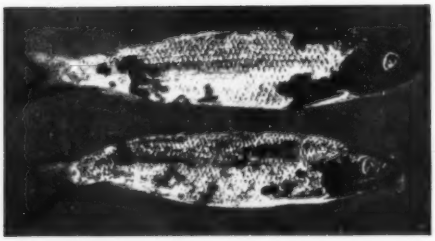
Longitudinal section of the light organ of *Anomalops* showing the parallel tubes in which the symbiotic bacteria grow. After Steche

The organ in each fish is made up of rows of tubes containing luminous material with blood capillaries running between them and a very rich blood supply, for the organ is extremely sensitive to lack of oxygen and becomes dark very quickly when the supply of oxygen is discontinued. Imagine my surprise upon examining the contents of the luminous tubes with a microscope, to find a mass of moving bacteria, curved rods in most cases. The organ was evidently a device for the growth of symbiotic luminous bacteria, and this view gives us an explanation of the continual luminescence of the organ. For luminous bacteria and fungi alone among luminous organisms emit a steady light independent of and unaffected by stimulation. In chemical behavior and reaction to various substances, the organ emulsion behaves just like an emulsion of luminous bacteria, and in my mind there is no doubt that the light of these fishes is due to symbiotic luminescence.

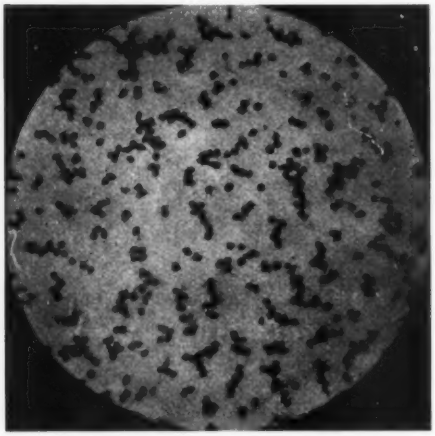
Despite many attempts to grow the bacteria in artificial culture media, no



Ordinary luminous bacteria growing in an artificial culture medium. Only the colonies and not the individual bacteria can be seen. After Molish



Dead fish infected with ordinary luminous bacteria. The bright spots are the colonies of light-producing bacteria. After Rosen



Highly magnified luminous bacteria, *Photobacterium javanense*. After Gerretsen

success was attained, or rather, I should say that bacteria from the organ would grow in artificial media but they never produced any light.

This may be due to the fact that these symbiotic forms require some peculiar nutrient material of the living fish which is absent in the artificial media. Most luminous bacteria of the sea grow with great readiness in any culture medium of the proper alkalinity and salt content. They appear as colonies on dead fish (before putrefaction begins) and have been known to infect living organisms such as sand fleas. The sand fleas become luminous, and the malady, finally fatal, can be passed by inoculation from one animal to another. There is no reason why symbiotic bacteria, requiring special nutrient materials, should not exist.

We have in these fishes another example of a mutual benefit partnership between two organisms. The bacteria get food from the fish but what the use of the light to the fish may be, I should hesitate to say. The natives say it is a searchlight. Certainly it is advantageously placed for seeing. The immediate field of illumination must be clearly visible to the fish. But I must confess skepticism regarding this as its real value. It seems incredible that the light of these bacteria can have been of such value to *Photoblepharon* that the complicated luminous structure, blood supply, and obscuring mechanism should have been developed. How did the organ ever get its start? Here is a problem for the evolutionary philosopher. Perhaps there will come to light some intermediate steps.

Other fish may harbor symbiotic bacteria. I suspect that *Monocentris* of Japan is one. Its light shines continuously day and night, and I should predict that any fish whose light organ shines continuously, is probably a harborer of symbiotic luminous bacteria. Let us hope for the discovery of such a form nearer home than the Banda Islands.

Whatever the intermediate steps in the evolution of this light organ, we see in *Photoblepharon* and *Anomalops* the final product in all its perfection; the light itself is steady and self-perpetuating, the supply of air is insured by a rich blood supply, and the screening can be instantaneously controlled.

The mud hut with roof and partitions of palm thatch in the village of Pirangi, in which Doctor Starks and his party lived while collecting in that region

Experiences of a Fish Collector in Brazil[1]

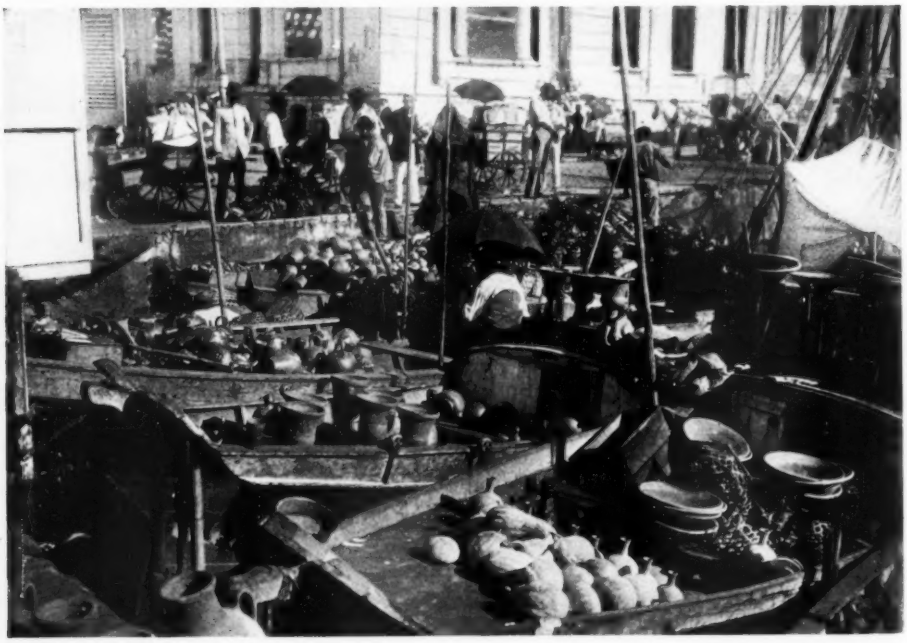
By EDWIN C. STARKS
Professor of Zoölogy, Leland Stanford Junior University

IT is May day and we are steaming into the Amazon. I can scarcely realize that right over there is a land of my boyhood dreams—a long line of low dark islands, or jutting capes of the mainland, closely covered with trees. The river is made up of definite streaks of dark water with darker water between. Strange leaves and seeds float past. Occasionally someone exclaims over the triangular fin of a shark cutting the water. More often the exclamations are called forth by logs and snags, that become all sorts of monsters in the eyes of the passengers. We hope in vain for a glimpse of the famous freshwater porpoise of the Amazon. Peculiar, long, snaky fishes, are frequently seen scurrying over the surface of the water in zigzag tracks to the right and left of the bow of our ship. Only their tails are submerged, but they make surprising time, sculling themselves like boatmen, and we wonder if they are on the way to become a new group of flying fishes in a few millions of years.

Para, with its big windows and high open doors, its pavements and sidewalks, its little wine shops and its

[1]This account of collecting in Brazil relates to a trip made in 1911, and is lifted almost bodily from my journal. The day-by-day sequence, however, is broken, and the parts extracted that relate especially to fish collecting. It is of an expedition to Brazil made by a party of eight zoölogists and geologists under the leadership of the late Dr. J. C. Branner, to study especially the region about Cape San Roque and northward. The photographs are by the author.

View of a basin in the harbor of Para next to the market. It is crowded with boats of many kinds laden with produce of many kinds



A nearer view of the basin adjoining the market in Para, showing in more detail th great variety of strange things offered for sale by the owners of the boats

numerous other details, recalls Naples rather than the other Latin-American cities I have seen.

We first visit the market, where one always sees the most life and color, for it is the shopping place for the great mass of people. Here we find strange fishes, reptiles, birds and mammals, likewise fruits and vegetables, many of which we have never even heard of before. Among the mammals are agoutis and armadillos and monkeys of which we may have seen pictures but never before have beheld in the flesh. In front of the great market building is a large basin crowded to overflowing with market boats which are loaded with all sorts of strange things—fish, pottery, vegetables, heavy timbers of various unfamiliar kinds, palm leaves for thatch, leaves, bark and seeds that we can only guess have some medicinal value. The boats are strange in shape and rig, with sails of various shades of brown, or occasionally sky-blue.

We find the zoölogical garden of great interest, for the animals all are living healthy lives in the climate in which they were born. There are tapirs, sloths clinging upside down in the branches, all sorts of strange monkeys that have never been brought alive out of Brazil, ant bears that have an attendant whose sole duty is to find ants for them, big snakes and gorgeous birds—all looking contented and at home.

Never were we so opulent! One of my friends "touched" me for a loan of ten thousand until he could get to the bank. We handle money in sums of which we have only dreamed before. We feel important until we reduce our money to the standard of home and find that each thousand reis represents thirty cents. For five dollars one gets fifteen thousand reis at the money changers. Every old market woman has a fat roll of bills, not one of which is below three figures.

We see crude rubber everywhere—on the docks, arriving in boats from up the Amazon, piled in the warehouses or being packed for shipment. Nearly every store has a little, for apparently everybody deals in it to some extent. Para is a child of the forest, for all of her wealth comes from out of the woods—rubber first, then timber, Brazil nuts, tonka beans, balsam, Peruvian bark, and many other forest products.

Prices are high. A straw hat costs from 1,000 to 10,000 reis. The boys have to pay ten cents for a coconut and are asked thirty-five cents for a pineapple. Perhaps it was because they (the boys) are green, but one can get them (the pineapples) for less in New York. Even street car fares are high, and it costs us from nine to twelve cents to ride distances much shorter than those for which we pay five cents in any of our own cities. Apparently the conductor collects an additional hundred reis whenever the humor strikes him.

After a couple of days our ship is ready to sail southward, and a voyage of about four days brings us to the town of Fortaleza, more usually called Ceara—the name of the state. Here we stay for about ten days, always hoping for the appearance of the boat that is to carry us to Natal. Ceara is a city of about 40,000 people, but like all Latin-American towns one would not guess nearly that number. The market is indescribable save by the brush of a skilled artist. The pottery vendors spread out their wares under the trees in a large splotch of rich red. With the gaily colored wearing apparel and piles of fruits and vegetables, it is simply color run riot. The town is much scattered; toward the outskirts

A fishing village near Natal, Brazil.—Drawn up on the beach are two *jangadas*, pointed rafts of logs roughly shaped like boats

are picturesque little thatched huts; down on the beach is the climax of picturesqueness in a long row of fishermen's huts with raftlike boats drawn up in front of them.

There is little collecting here. The fishes in the market are the common ones caught with hook and line. Once or twice I follow cast-net men along the beach with little reward. The shore here is a clean-swept sand beach, but there are some rocky tide pools about five miles away. Early one morning several of us set out to walk to them. Our way lies along a hard sand beach. It is delightfully cool. A lighthouse on a distant point looks twice as far in the haze arising from the surf as it actually is. It marks our destination. We pass three different fishing villages among the palm groves. In front of the grass and mud huts are the raftlike boats known as *jangadas*. The *jangada* is simply a pointed raft of logs in the shape of a boat. As the waves wash over it at will it does not answer to the description of a boat in the nonsense verse: "A boat's to keep one's feet from getting wet when one is on the sea." There are various sizes of *jangadas;* little ones for one man to paddle, and big ones that carry a large stretch of canvas and several men. Considering their construction, they are surprisingly swift and seaworthy. The fishermen go long voyages on them, venturing even out of sight of land.

Natives pass us in a continuous procession, some on donkeys, but most of them making beasts of burden of themselves. They are on the way to market carrying produce of various kinds.

Never in all my fish-collecting experience have I seen more promising pools than those we find at the end of our walk, but they are almost bare of animal life. I find only four kinds of fishes, where I should find a dozen or more kinds to compare with the tide pools I have known elsewhere.

At noon a porter arrives from the hotel with our so-called "breakfast." We fare royally under the palms, for the great box that he has carried all of these miles on his head contains all of the courses and china dishes that we would have had at the hotel. Then for a few pennies we hire some natives to climb the long, slender coconut palms and pitch down the green nuts that seem to be community property of the

villagers. The rich milk, contained in the nuts before the meat has hardened on the shell, makes a very delicious addition to our repast.

Next, a rail journey into the interior takes two days. We travel in our own private train furnished with the compliments of the railway people, some of whom accompany us. Our train consists of two long, plain cars, with loose chairs instead of stationary seats, and with hammock hooks on the walls—these and the hammocks being all that make a sleeping car in Brazil.

We stop sometimes at an outcropping of rock that the geologists wish to see, or sometimes at a likely-looking place where beasts might lurk. The end of our journey is Quixada, where we spend the night. In all directions great rock hills arise straight from the plain like gigantic bowlders. After dinner we sit in front of the little hotel in the light of the full moon, and, although we are within a couple of degrees of the equator, it is as cool as a summer evening at home.

The little town of Quixada nestles at the base of a great rock rising out of the plain. In the small lake in the foreground the inhabitants do their washing

In the morning I obtain a few small fishes from a pond near the village. These, with some lizards, are all the region contributes to our vertebrate collections. In this region the rich fauna of Brazil, of which we have heard so much, is conspicuous by its absence. Even insects are scarce, with the exception of mosquitoes. Of these I speak feelingly, for last night in my hammock I would often awake after a short, fitful sleep, to find myself "tacked down" by mosquito bills from below.

The village of Pirangi, showing the beach and also the palm trees in which the little town is embowered

Our ship comes into the harbor after we have remained at Ceara much longer than we had anicitpated. She is a large, dirty boat, commanded by a big American whom we later find upon closer acquaintance to be a rather decent fellow full of troubles of his own. Not being able to get good rooms together, we are scattered over the boat. My roommate is a mahogany-colored gentleman. I retire early, and as I am about to climb into my berth, I note a peculiar handle protruding from under his pillow. Curious, I draw it out, and find it to belong to a slender stiletto with a blade a foot long and a point like a needle. My back twitches in fearful expectation all night. But later we find that everyone wears a stiletto, and that the elaboration of the handle is an index to the prosperity of its owner.

Our old tub of a boat limped into Natal last night with a very bad list and we anchored outside of the reef until this morning. As we run into the quiet waters of the harbor, a steamer flying the government colors puts off from shore and we find to our surprise that we are the reason, for our chief, the late Dr. J. C. Branner, is a great man in Brazil. We are at once carried on shore, where we find a sumptuous breakfast awaiting us. Then we are taken to a new house, next to the governor's residence. The owner has donated it and our new friends completely furnish it for us from their own homes, so that we are very comfortable. After this we are officially received by the governor with gold lace and champagne, and then we are left to ourselves.

Our boxes of freight are placed in a large government storehouse opening on the water front and here we expect to do our laboratory work. The harbor extends for some miles inland as a mangrove-lined estuary. Across the

mouth of it is a reef, over which the waves wash at high tide. As we have been obliged to give up the idea of cruising northward along the coast, we feel that we can find plenty to occupy us here for a considerable time.

The next day a couple of us hire a boat and go on a dredging and seining trip. Our most notable seine haul is made in a pond into which the high tide flows. It is about a hundred feet across and three times as long, and as my fine-mesh seine just reaches across it, I am able to collect about all it contains. The haul proves to be a very rich one, and is the real beginning of my collecting.

The governor has given us the use of the steamer that met us upon our arrival, and the next day we make a short cruise. The consequence is that I am now lying beside a little stream near the village of Pirangi writing in my journal and trying to recover from a pernicious attack of seasickness, for the waves handled that little steamer in a very careless manner, piling themselves on deck so that we had to stay on top of the cabin to keep half dry. The cool shade of the mangroves is a very agreeable change from the hills and valleys of the sea. Across the stream are other mangroves standing on tiptoe in the water, their exposed roots forming a strange, tangled network. Three long, slender, brilliant green garfishes swim past up stream to get a taste of fresh water, while behind them, paddling ponderously along like old-fashioned ironclads, are some globefishes. A flock of yellow and green parrots perch on the trees near me and very frankly discuss me. Though I understand little Portuguese, I comprehend perfectly what they think of me, and the knowledge is not encouraging.

I walk back to the little thatched village and see a great circle of twenty or thirty men and boys under a big spreading tree that at once reminds me of the council tree where Buldeo told his famous lies. White helmets mark our party in the middle. I draw near and find a couple of natives opening cocoanuts for my friends to drink the milk.

We are boarded in a little mud hut whose roof and partitions are made of palm-leaf thatch. We are in a condition to eat and appreciate anything that is placed before us, and lucky we are to have appetites to tackle some of the things. Five of us sleep so close together in a room that our hammocks nearly touch, and the other three sleep under a thatched roof supported by poles and without walls. When the people gave up their room to us, they had only themselves and their hammocks to move. It is the main living room of the house, too, and in the daytime the women occupy it, bringing in the cushions on which they make lace, placing these on the ground in front of them.

We are reminded of when the circus comes to town. We are the circus. Our kind never stayed with these people before. Our zoölogical collecting and geological rock-cracking are beyond their comprehension, except that they are sure, of course, that we want fishes and reptiles and insects to make medicine of. They follow us everywhere. When we retire, they look in at the doors and windows in a perfectly frank way. We can scarcely bar them out because, though we are paying for all that we receive, we are their guests.

A couple of days gives us all the village has to offer and we return to Natal over a quiet sea.

The fish market at Natal is very poor for collecting purposes, and though I

frequently visit it, I find little that is good. But I get very desirable specimens from the pools left among the rocks when the tide is low. I poison the pools with chloride of lime, which drives the fishes from the crevices

Portrait of the little blenny, *Salariichthys textilis*, which leaped out of the pool and over the sand to escape capture. After Jenyns

among the rocks so they may be dipped out with a small net. There is one common blenny, however, that never waits to be dipped out, but leaps out of the pool and makes rapid progress over the sand to the sea and is captured with some difficulty.

Owing to the scarcity of fishes, a local merchant has imported from Hull, England, a trawling steamer with its crew. He believes there would be a very good market for fishes, could they be caught. The boat is large, and the trawl is a huge affair with a net made of rope. It weighs tons and is hoisted by a steam winch. In a haul it sweeps the bottom over a space ninety feet wide by about three miles long. A couple of us make an expedition in the trawler on a trial run, but alas, the net catches on a coral reef and is badly torn. A small corner remains, however, full of good things. The entire catch is given to me. A couple of days later we try it again, but this time tons of seaweed fill the net and it splits wide open as it is brought aboard. The trawler does not make another trip during our stay.

We have been given passes on the two railroads that leave Natal in different directions, and one day we board the train for Lake Extremoz. This is a long serpentine body of water, the remains of a former river, and its isolated fish fauna should be very interesting. We try to leave without letting our departure become known, but some of our friends telegraph news of our coming, with the result that we are met by a civil engineer who makes us his guests. I carry a fine-mesh seine, and we hire the head fisherman and two other natives with their great dugout canoe to help drag it. But our work is futile, for the lake bottom is covered with a mass of half-disintegrated vegetable matter held in suspension that chokes the seine, and we can-

One of the small boys of Ceara Mirim, who was such a good collector

A member of Doctor Starks's party with a crowd of enthusiastic small boys who gave valuable help in collecting at Ceara Mirim

not get it ashore on account of the weight. I capture a few fine specimens in the soft, oozy matter. They are an aggravation in showing what I have missed.

After returning to Natal for a day we make a collecting trip to Ceara Mirim, that lies a few miles farther along the railway from Lake Extremoz. Here we find very good collecting in a little stream with several disconnected ponds. But we very soon find that the unusually abundant small boy can get the specimens we want better and easier than we can.

We keep office hours in our little hotel, and boys are continually arriving with fishes, snakes, lizards, land shells, and insects, as well as with a host of things we do not want. We have made a scale of prices for the things we want and we have to bargain before we get them. It almost causes heart failure to say "No" to a boy when he wants too much for a desirable specimen and then shut him out of our room. But they always meet our price for they know it is fair, and as they always rush gleefully away to get more of the little beasts (*bichos* is as it sounds), we know they are satisfied. In fact we soon have grown men engaged in the chase.

The whole hotel swarms with men and boys, for everybody comes to look on, and the idle boys have to be continually driven outside. When we wish to work we lock ourselves in, only opening the door for more specimens.

The boys are the best boys we meet with in our travels, as well as the best collectors. Some of them have little guns made of gas pipe, fired by snapping a steel umbrella rib against a paper cap. They use balls instead of shot and shoot surprisingly well con-

sidering the guns. Others are very expert with a sling, or with a bow arranged to shoot stones instead of arrows. One boy who collects lizards for us scarcely ever misses his mark, getting as many with his crude apparatus as we can with a gun.

Water carrier at Ceara Mirim. The water jar rests on a wreath of green leaves twisted about the head to form a cushion

The public well, whence the death-dealing drinking water comes, is the place where everybody meets everybody else. The water is carried by mule power in long wine kegs, or often in picturesque red jars, on the heads of natives—the only head work they ever do. Usually the jar rests on a wreath of green weeds twisted about the head to serve as a cushion. These natives, like all peoples who carry burdens on their heads, have beautifully erect bodies and straight backs.

The tide-pool collecting is the most profitable and pleasant about Natal. The pools are large, with fine white sand on the bottom. The water is warm and clean, and the sun is not too hot. It is great fun wading about in the pools, scooping up the fishes as they come from the crevices of the rock. One never knows what unusual specimen may next reward him. Occasionally I sit on a rock and describe the brilliant colors of the fishes that so quickly fade after death.

As a result of this exposure to the tropical sun, I am gradually losing my entire skin. First I left my hat off when I was collecting, and the top of my head (*sans* hair) grew rosy red and peeled in a couple of days. Then I worked with my sleeves rolled up, and the skin of my arms followed. Now I peel huge sheets of epidermis from my legs. But one peeling is followed by that part turning black and it does not peel any more. I have about reached the limit of possibilities.

Our next trip is to the town of Itamatahy, 165 kilometers from Natal by rail. We pass first through a region of tangled, scrubby growth among the sand-hills; then through a level plain dotted sparsely with shrubs and trees and covered with bunch grass. It is typical desert land such as we have in Oregon or Nevada. Further on the trees grow higher and more tropical and tangled with vines. Sometimes we look into fertile valleys, green and wild or filled with plantations of cane, cotton, or bananas.

Houses with dull-red roofs cluster in little villages, with the ever-present palm trees. At intervals along the track are little thatched mud houses. Here the whole family turns out to see the train go by; women in slatternly calico dresses, dirty and patched, smoking short black pipes; lazy brigands, leather-hatted, belted and bedaggered, ill-favored and ill-flavored; naked bronze "kids" with pot bellies and slender legs; and in the doorway some chick-

"Main Street" in the town of Papary. On the lake of that name was held the fishing *fiesta* which brought so many interesting specimens to Doctor Starks

ens, goats, or pigs: all are equally interested in the only event that breaks the monotony of the day.

We spend the night with an American engineer in charge of the building of a branch railroad. Two of the party, finding here the things they are interested in, conclude to stay longer, but the rest of us return toward Natal by an early train with the intention of visiting Lake Papary for a day or two.

Reaching the town of San José, we leave the train and soon find ourselves tramping along a narrow green pathway lined with tropical shrubs and trees, accompanied by two donkeys and the necessary natives to drive them. Our suitcases, alcohol tanks, and other belongings swing from the sides of the donkeys, and a light drizzle of rain keeps us delightfully cool.

Reaching Papary we present a letter from the governor to Colonel Carvalho, *Presidente do Governo Municipal*, and we at once own the town and all of its inhabitants. It is the best town we have ever owned, and our new friend, Colonel Carvalho—what can I say of him more laudatory than that he is a "brick?" He owns a nearly-new five-room house close to his own, and throwing wide its doors, he asks us to accept it for as long as we can be happy. He wants us to board with him, but when we decline the invitation, he gets us a cook and servant, and so here we are keeping house under our own vine and fig tree.

We are on one side of the village plaza. At the back door stands our moss-covered cistern—a picturesque piece of pottery, about the shape and size of that which Ali Baba used to pack each of his forty thieves in. Several tropical trees grow in our backyard. Corner-wise, with a gate between, is the yard of our host, filled with trees and shrubs among which

wander all sorts of strange animals that he has collected. One, an old monkey, with all the wisdom of the ages behind his gray eyes, gazes over the fence.

My journal contains much of this little town, but I am forgetting my fish collecting. One morning the Colonel takes us on a walk to the lake, where a big canoe manned by some natives awaits us. Low stools are placed for us to sit on, while the men kneel at their paddles. We skim down a long, winding, green lane of oily water, lined on both sides with rushes and with water hyacinths bearing beautiful clusters of big lavender blossoms. It is a glorious ride. We float silently along, not a sound breaking the quiet save the ripple of water under the bow of our boat. Occasionally, as we turn a corner, strange water birds rise and fly ponderously away, and mullet jump all about us. At last we glide out on a beautiful lake that loses itself in the distance among islands and headlands.

Perhaps never before has my soul been so filled with poetry and romance, as when on this cool fragrant morning we glide so smoothly and quietly over miles of glassy water. Even the natives feel the enchantment of it, for no one speaks. Occasionally we stop to draw up one of the poles that here and there stick above the water, and bring to the surface a fish trap of basket work.

After a time, away off against a distant bank of trees, we see moving objects, which, as we draw nearer, prove to be canoes. Soon we see that they are headed for us—canoe after canoe loaded with picturesque barelegged natives. One of them is an expert at blowing a conch shell, and its booming trumpet-note comes echoing across the water, adding a touch of weirdness to it all. When they are all about us, we are the nucleus of a band of a dozen canoes. They have been fishing and have baskets of specimens from which the Colonel assures me I may select.

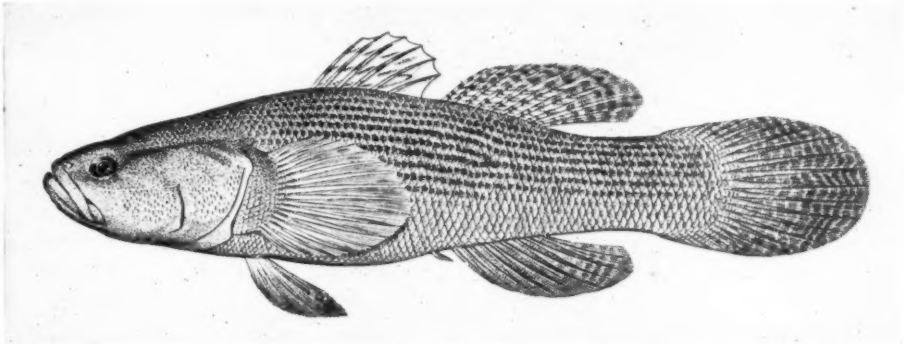
We are told that there is a law against a certain kind of destructive fishing, but for our benefit the governing body of Papary has annulled the law for the time being. These fishermen have been brought together not only to get specimens for us, but to entertain us with a fishing tournament. Operations are begun when two big canoes, that have a great gill-net loaded equally in each of them, take their stand at one side, while the other canoes scatter in the opposite direction. The first two paddle away from each other paying out the net in a great circle. When the circle is two thirds complete, and the two canoes are headed toward each other, the other boats begin closing in, their occupants making the greatest noise and commotion possible—splashing, yelling and hammering the sides of the canoes with paddles—evidently with the idea of driving the fish into the net.

It all looks and sounds very barbaric—South African or perhaps just Brazilian. The circle of gill-net is now complete, and the canoes pass over the floats of the net and are inside, where the men begin using cast-nets. These are the biggest of their kind I have ever seen. They are at least twenty-four feet across and are thrown with great skill and strength. It is a pleasure to watch them in use, the men, straight and erect, swaying their bodies like trained athletes, the muscles of their naked bronze backs standing out, as with a great heave the nets fly into the air, spread themselves, and fall in a perfect circle. Every cast brings in fishes. Those that are not caught in the cast-nets are driven into the meshes of the big net and gilled. The men seem

to be having lots of fun in breaking the law with the *Presidente* looking on. We have all sorts of high jinks and canoe races on the way home, and the men shout and joke with each other in quite a holiday mood. My only regret is that I left my camera at home.

Upon our return we find the whole village out in force to greet us. Each sweep their walk and generously include ours also. Sugar cane, coconuts, oranges, and limes are sent in quantities by the good people. Our house is a regular museum with iguanas, turtles, snakes, and monkeys running about to the limits of their tethers.

One morning I take a long walk to the railway station to meet some of our



Eleotris carvalhonis, a goby taken by Doctor Starks in Lake Papary and named in honor of the genial Colonel Carvalho, who gave such valuable aid in collecting fishes from that lake

man spreads his catch on the shore and I am invited to take what I care for. The Colonel will not allow us to give the men any money, though we try to slip some to them on the sly. The fishes I select are placed in a basket, crowned with a big fish for dinner, and delivered at our house.

The next day a large basket of fish is delivered to me by the Colonel's orders. The men have been fishing all night, and I am told that I now have all but a few of the kinds to be found in the lake. The fishes are mainly strange armored catfishes. On two other occasions baskets of fishes are brought to me. When we try to pay the men something, they make very sure that the Colonel is not in sight before they dare accept any remuneration.

This is a very friendly town. Every passer-by looks in at the window to wish us a good-day. Our neighbors party who are expected from Itamatahy. As I walk along the path, a big black attaches himself to me, sticking close behind, and I remember his long stiletto as we pass through the lonely woods. His bare feet make no noise on the soft path, and I find myself frequently glancing back like the little girl on the dark stairs. It turns out, however, that he is one of our fishermen, and has made himself my protector in quite a feudal way. When we reach the station he makes it very evident that he is with me. When I say "No" to an importunate beggar, my swart friend catches him by the arm, and I understand enough of his tirade to know that he tells the beggar that when I say "No" I am not to be bothered. The people discuss me in a very frank way, taking turns at asking me questions to learn if it is really true that I speak no Portuguese.

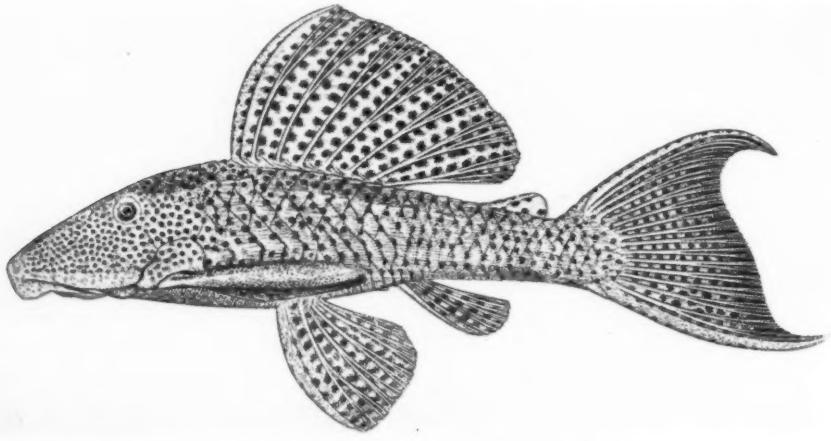
After some days we leave Papary with regret, to return to Natal. The very hospitable Colonel seems sorry to see us go and stands waving us farewell as long as we are in sight. What a world this would be to travel in could one always meet such a Colonel!

The last collecting trip I make from Natal is to the head of the estuary that forms the harbor. A kind Scotchman who has an establishment for the manufacture of various cottonseed-oil products, has invited a couple of us to go in his big sailboat to visit him. We have a beautiful sail through the mangrove-lined water lanes. We can spare only a couple of days, for the steamer which will take us northward is soon due. I carry my seine and our host loans us a boat and some of his men to help us, and I get a number of specimens that I have not found in the lower harbor.

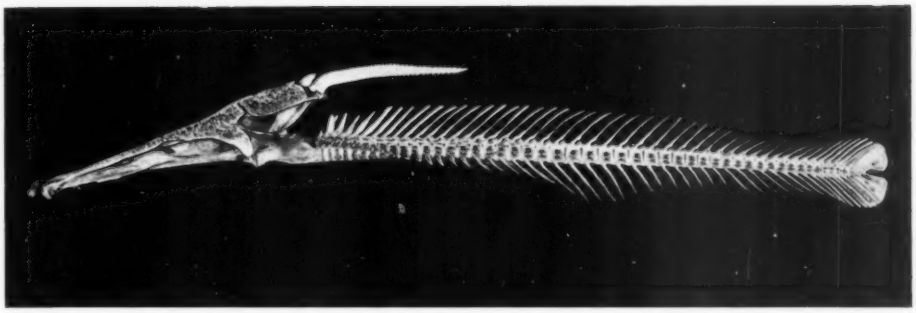
In July we leave Natal, and after a very fine voyage arrive at Para, where we spend two weeks. The Amazon fish fauna is less well-known than I had supposed, and as the fish market is large I am able to get a very good collection. Every morning I go to the market and hire a man with a tray, who follows me around from stall to stall and receives the fish as I buy them. Prices are high. Perhaps I am cheated somewhat, but not much, for a friend of the consul's accompanies me the first two mornings, and I get some idea of what the prices should be. Always I have to bargain for every lot.

My specimens from Brazil are representative of a most interesting fish fauna, composed largely of the very strange catfishes that have been more or less familiar to me as pictures. If from all the fishes of the world the most peculiar ones were picked out, they could be matched for strangeness among the catfishes. One feels that if he were living in the Devonian or Carboniferous Age, and were collecting fishes, he would find just such a lot of unfamiliar and strange forms as these.

We have a very delightful voyage northward, and we view with satisfaction the Southern Cross sinking below the horizon and the North Star climbing up toward its familiar place in the sky. But it is with more satisfaction that we at last behold the fair bronze lady who guards our liberty as we sail into New York harbor.



Plecostomus pusarum, one of the strange armored catfishes of the waters of Brazil. This one looks as if it had not descended very far from its Devonian ancestors



Lateral view of the axial skeleton of a crucifix catfish from the West Indies. Photograph of a specimen presented to the American Museum by Mr. George Stone of New York City

The Crucifix in the Catfish Skull

By E. W. GUDGER
Associate in Ichthyology, American Museum

THE early explorers of the New World found it indeed to be a new world in its animals and plants as well as in its lands and peoples. In its fauna they found tapirs, not elephants, llamas and alpacas and vicuñas instead of camels and dromedaries, cougars and pumas in the place of lions and tigers, humming birds contrasted with nightingales, iguanas replacing fence lizards, rattlesnakes taking the place of harmless adders, and—the list might be indefinitely extended. But nowhere perhaps was there greater contrast between the faunas of the new world and the old than among the finny inhabitants of the waters.

Natural history explorations were long confined largely to southern North America, Central America, and northern South America, and in the waters, salt and fresh, of these regions were found fishes of many kinds never before seen by the eyes of white men. Among the fresh-water kinds, this region is especially characterized by members of that group, the *Nematognathi* or whisker-jawed fishes, colloquially called catfishes. While in Europe this group is represented by but two species (one of these being confined to Grecian waters), in America there are found at least 250 species or quite one fourth of all the species of catfishes known in the world.

In the tropical and warm temperate waters of the great rivers of America, especially in the Amazon and Orinoco and their tributaries and in the rivers of the Guianas, and also in the salt and estuarine waters of the Caribbean-Gulf region, these *Nematognathi* in vast numbers live, move and have their being. They are rather primitive forms which early split off from the piscine stem and to this day retain many primitive characters. Of these whisker-jawed fishes, the largest family, the Siluridæ, are the ones best known by the name "catfishes." These Siluridæ have broad heads, scaleless slimy skins, fins both pectoral and dorsal provided with large jagged spines, and mouths bedecked with short or long barbels or feelers.

In the salt, brackish, and fresh waters of the countries bordering on the

Spanish Main are found many siluroids of the old genus *Arius* (Greek *areios*, martial, from *Ares*, Mars), so named because they have a bony buckler or shield extending from the base of the skull backward to the strong spine of the first dorsal fin. This may be seen in the lateral view of the skeleton of one of these fishes which forms the headpiece to this article and in the dorsal view of the same skull on page 378. Furthermore, the skulls of many of these fishes show on their ventral surfaces a fairly recognizable representation of a crucifix, and among the inhabitants of the countries referred to above these catfish skulls are held in a superstitious esteem amounting almost to veneration.

In reading books describing travels in South America the present writer has at various times run across accounts of the superstitions of the natives regarding these crucifix catfish skulls but, for the most part, they cannot be recalled now. However, there are one old and two recent references which may be cited. The first of the recent accounts is found in a delightful book by Mary B. and C. W. Beebe,[1] on life in the coastal regions of Guiana and Venezuela. While the authors were anchored in one of the many distributaries of the Orinoco delta, the fishes attracted their attention, and of certain ones they say:

> On the bottom our hooks would sometimes be taken by great fierce-whiskered cats, bedecked with long streamers, which gave no end of trouble before they were quieted. They were pale yellow, and head and back were encased in bone; Mæstro (the cook) called them the crucifix fish, and later showed us why. On the under surface of the bony armor is a large cross with a halo about it just above the arms. The crew never caught one of these fish without making the sign of the cross in the left palm.

The figure which they give, and the one which really prompted me to hunt for other crucifix skulls, is from a photograph of the ventral surface of the skull of one of the catfishes to which they refer. The details of this skull are not sharp and clear because it had suffered considerable abrasion, and hence it does not seem necessary to reproduce it here since other and better figures will be shown later. The fish was unfortunately not identified as to genus and species.

The next account and figures are found in Doctor Eigenmann's great monograph on the fresh-water fishes collected in British Guiana.[2] He writes:

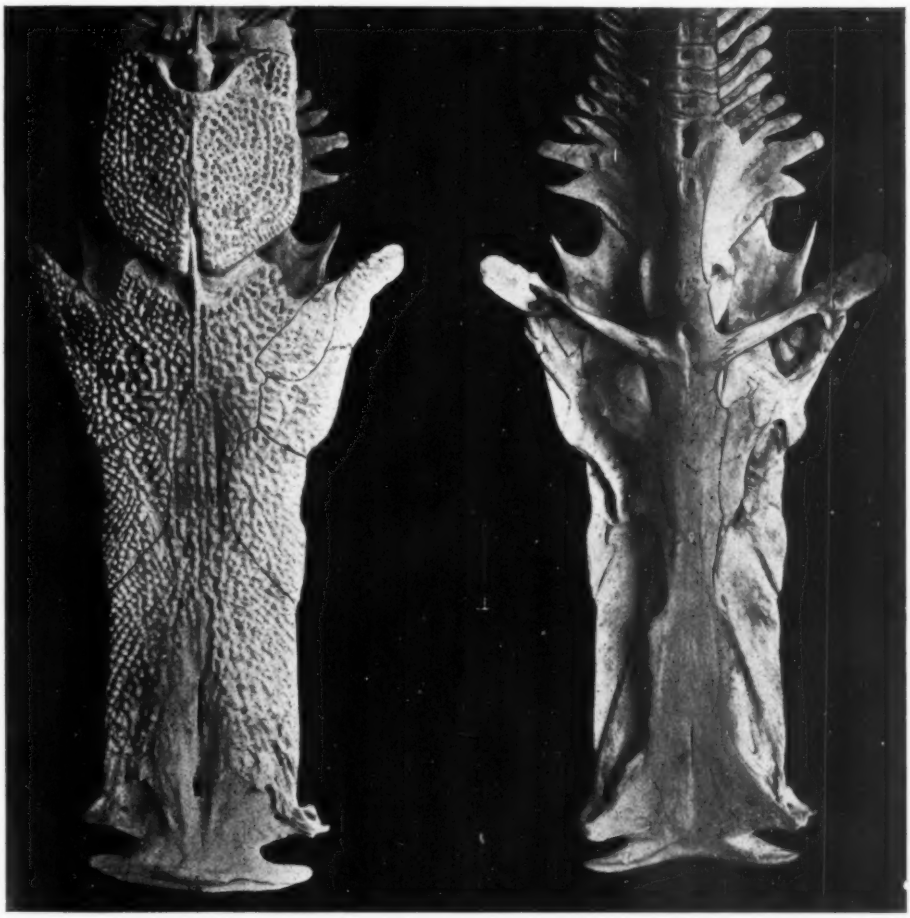
> The skeletons of a variety of Ariinæ are prepared and sold as crucifix fishes. The one which is most frequently prepared is *Schiadeichthys proöps*. The dorsal surface of the skull and dorsal plate are pointed out as resembling a hooded monk with outstretched arms. The ventral surface resembles the cross. Fancy pictures the dorsal spine as a representation of a spear, while the otoliths, which rattle when the skull is shaken, are dice with which the soldiers cast lots for the garments of our Lord.

Eigenmann's figures are both reproduced herewith. The dorsal view (left) shows the robed and hooded monk with outstretched arms, while above the hood there may be seen the base of the dorsal spine representing the bottom part of the spear. The ventral view shows the crucifix. The stem or trunk of the cross is made up of the main basal bone of the skull, the parasphenoid, and the arms of the cross are composed of the post-temporals. The outer ends of these, expanded to accommodate the articulation of the bones of the shoulder girdle, give somewhat the idea of outstretched hands.

The halo is composed of certain little bones, called the Weberian ossicles after the name of their discoverer

[1] Beebe, Mary Blair and C. William. *Our Search for a Wilderness*. New York, 1910, p. 13, fig.

[2] Eigenmann, C. H. "The Fresh-water Fishes of British Guiana." *Memoirs Carnegie Museum*, Pittsburgh, 1912, Vol. 5, p. 106, pl. VI, figs. 1 and 2.



Dorsal view (left figure) of the skull of *Schiadeichthys proöps*, a catfish common in the Guianas. Note the resemblance to a robed and hooded monk. The ventral view (right figure) shows the crucifix and the halo. After Eigenmann

which have long been known to connect the air bladder and the internal ear and hence were thought to be homologous with the three auditory ossicles of our ears, and accordingly to play a part in the transmission of sound and in the function of hearing. Now, however, it is pretty well demonstrated that while they do connect the air bladder and the membranous labyrinth of the ear, they are a part of the complicated apparatus having to do mainly with the maintenance of equilibrium in the fish. In position these halo bones lie ventral to a plate composed of the expanded lateral processes of the coalesced anterior vertebræ. This plate then covers and protects the anterior end and dorsal part of the air bladder. Especial comparison of this structure in this skull with similar structures in other skulls will be made later.

Below the inner or basal portion of each arm is an expanded and rounded region of the skull called the bulla, in which was contained the membranous labyrinth of the auditory organs and in

which are now found the otoliths or ear stones. When the skull is shaken the noise made by these is compared to the rattling of dice as noted by Eigenmann above.

Seeking further data on the crucifix catfish skulls, I wrote Mr. Leo E. Miller, formerly connected with the American Museum, and a traveler and collector of large experience in northern South America. He courteously answered that he had seen these crucifix fish skulls frequently in the Orinoco region, that such were commonly found in the curio shops in the West Indies, and that stories such as Doctor Eigenmann gives were very current throughout the northern part of South America and the West Indies.

These statements are confirmed for the Guiana country by Mr. Herbert Lang, associate curator of African mammals in the American Museum, who on a trip to this region in 1922 brought back from Georgetown such a skull fancifully painted and decorated. Furthermore, Mr. James Rodway, the experienced naturalist of the Guiana Museum at Georgetown, British Guiana, very kindly has written me that "crucifix fishes" are common, and their skulls can be obtained everywhere, the catfish (*Sciadeichthys proöps*) referred to by Eigenmann furnishing the greater number.

Dr. G. K. Noble, curator of amphibians and reptiles in the American Museum, while on an expedition to Santo Domingo during the summer of 1922, saw a crucifix skull in the province of Bara Hona on that island. This was very much venerated by the natives there, being looked upon as a sort of fetish or charm against danger and sickness.

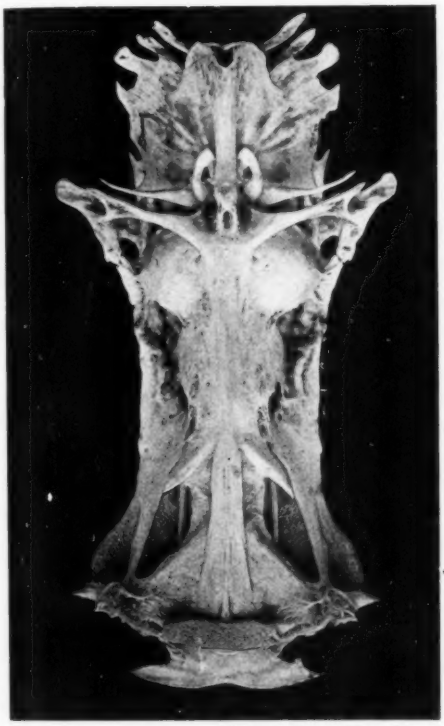
Far earlier, however, than the accounts of any of the persons cited, is that by Antonio de Alcedo,[1] long a resident in northern South America. In the appendix to his book (1789) he writes of a catfish called "Capitan" or "Chimba" that it is "found in the rivers of the new kingdom of Granada. It is the *Bagra* of other provinces . . . It has been remarked that, when the bones of the head are separated, each represents some one of the instruments of the passion of our Redeemer, forming the spear, cross, nails, etc."

Such structures as these referred to I have found in two ocean catfishes (*Felichthys felis* and *Galeichthys felis*) which are not uncommon along our Atlantic coast and in our brackish waters certainly as far north as Cape Hatteras. One of these, *Felichthys felis*, the gaff-topsail, is abundant in the summer at Beaufort, North Carolina, and years ago in skulls from which the flesh had been macerated I found the crucifix beautifully delineated.

This skull has been elsewhere figured and described,[2] but is herein shown again in the ventral aspect. Here we have the main trunk of the cross with the extended arms. Above this is the halo and this, together with certain rugosities just above the junction of the arms of the cross with the main trunk, gives a fanciful representation of the human face. Above, and extending to the right and left, are the ventral edges of the expanded and coalesced anterior vertebræ which, as previously explained, cover and protect the anterior part of the air bladder. These bones will hereafter be called "wing" bones because in their shape and position they

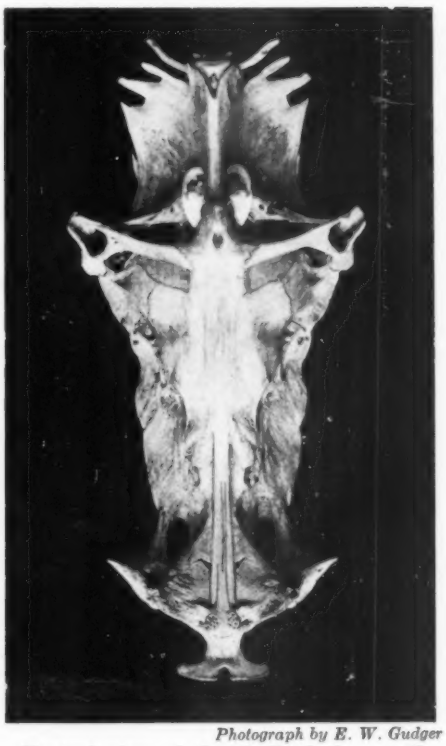
[1]Alcedo, Antonio de. "*Diccionario geografico-historico de la Indias occidentales ò America.*" Madrid, 1786–89, 5 vols. English translation with large additions by G. A. Thompson. "*The Geographical and Historical Dictionary of America and the West Indies.*" London, 1812–15. 5 vols. Appendix, p. 25.

[2]Gudger, E. W. "The Gaff-topsail Catfish (*Felichthys felis*) a Sea Catfish that Carries its Eggs in its Mouth." *Zoologica: Scientific Contributions New York Zoological Society*, 1916, Vol. 2, pp. 148–150, fig. 29.



Photograph by E. W. Gudger

Ventral view of the skull of the gaff-topsail catfish, *Felichthys felis*, of our Atlantic and Gulf coastal waters. Note the crucifix, the halo, the "wing" bones, and the faint resemblance to the human face. Below, note the masses of bony tissue simulating the feet and legs. Also note the tooth pads



Photograph by E. W. Gudger

Ventral view of the skull of the smaller ocean catfish of our south Atlantic and Gulf coastal waters, *Galeichthys felis*. Compare this figure with that on the left as to the crucifix, halo, and position of "wing" bones. Note also differences in anterior region in shape and position of the bones

show some faint resemblance to the "wings" of the conventional angel. Anteriorly on either side a bone reaches out from the median region of the skull and anastomoses with the bones forming the anterior part of the skull. These bones and the others to which they are attached simulate legs and feet pretty well if one exerts one's imagination ever so little.

In the lower angle formed by the arms and the trunk of the crucifix are found the bullæ, here very large and prominent—much more so than in the preceding skull. This is due, in part at any rate, to the fact that the skull of *Felichthys* is much wider in proportion to its length than either of the skulls previously referred to, or indeed in any of those figured later herein.

The other ocean catfish, referred to above, is *Galeichthys felis*, a smaller fish, very common along the Gulf coasts of the United States but not so abundant at Beaufort as its congener. Its skull has never been figured before. Not having a specimen of this fish, I procured one through the courtesy of Mr. B. A. Bean of the United States National Museum, and maceration gave the beautiful skull seen in the next figure. Here again the crucifix structures are very clear, especially the face, as shown in the adjoining bones. The

more nearly horizontally placed arms partly obscure the bullæ, which are less prominent than in the preceding figure. The legs are also clearly shown. The anchor-like structure of the anterior part strikes one forcibly, and still

A West Indian crucifix skull, lacking tooth pads on the roof of the mouth. Photograph of a specimen belonging to Mr. M. C. Marshall, Bellaire, Queens, Long Island

Photograph of another West Indian catfish skull (Mr. Stone's specimen). This differs from its mate chiefly in having tooth pads in the roof of the mouth

anterior to this we have a structure which can only be compared to the "bitts" on the deck of a boat or on a wharf for securely holding a cable.

The American Museum is the fortunate possessor of two fine skeletons of crucifix fishes of another species neither of which, however, are we able to name. The first was presented by Dr. Jonathan Dwight, research associate in North American ornithology in this institution. Doctor Dwight is unable to give the source of this skeleton but the assumption is that it was secured in the West Indies. The second we owe to the courtesy of Mr. Otto W. Jonmersbach of Brooklyn, who tells me that it also came from the West Indies.

While this paper was being written, Prof. M. S. Farr, Princeton Uni-

versity, came to the department of fishes seeking certain data, and saw my specimens. On his next visit he brought me a fine skeleton of a crucifix fish and this on examination proved to be identical with the two preceding skulls. It is, however, much larger, coming evidently from an older fish.

In addition to the skeletons just referred to, I have had an opportunity to study four others of apparently the same species of catfish. This beautiful series is the property of Mr. M. C. Marshall of Bellaire, Queens, Long Island, through whose courtesy I have been privileged to examine them. As to their origin nothing is known save that they came from the West Indies, and probably from the eastern region. All four seem to be representatives of a single species, the same as that to which the other three belong, probably a species of the genus *Sciadeichthys*.

A photograph of the best of these is herewith reproduced. Here we have the same structures that are found in the others, the differences bring in details. This skull is long and narrow, with little difference between the diameters measured across posterior, middle, and anterior regions. Attention is called to the bilateral tooth pad far in front.

The last skeleton, with which I have had the pleasure of working, is by long odds the most beautiful I have ever seen. It was presented to the Museum by Mr. George Stone of this city, and is also of West Indian origin. This skeleton has had the flesh so skilfully macerated and removed as to leave it almost absolutely intact and united throughout so far as the axial portion is concerned (the fin structures are gone, as is to be expected)—all of which may be seen in the lateral view at the head of this article. The subjoined figure shows the skull in ventral view. Here all the crucifix structures are beautifully shown, so much so as to call for no particular explanation. Undoubtedly this skull is very similar to the preceding, possibly so close as to be put in the same genus, but there is one marked structure in this not found in the preceding—the two tooth pads on the anterior part of the roof of the mouth. These are structures found in only one other skull examined, that previously referred to as brought back from British Guiana in 1922 by Mr. Herbert Lang of the Museum staff. This latter skull shows remains of a tooth pad in the same part of the roof of the mouth where unbroken pads are found in the skull of Mr. Stone's specimen. Since these skulls seem identical in other respects, they are referred to the same species.

The last figure to be given is a dorsal view of this same skull. The robe of the monk, the extended arms with the covering robe, the cowl or hood (the dorsal buckler) and the spear of the Roman soldier (the dorsal spine) can all clearly be made out. This figure should be compared with Eigenmann's portrayal of *Sciadeichthys*, and comparison should also be made of the ventral views of the two skulls. The ventral structures are plainly very much alike. The absence of intermaxillary tooth pads in Eigenmann's figure means nothing, since they have been torn off in cleaning the skull, as they have been in the two skulls referred to on page 376. However, the presence of tooth pads in the roof of the mouth of the Stone specimen, and their absence in Eigenmann's specimen and in all the six just considered, in every one of which there is no trace of them whatever, leads me to make of the Stone specimen a separate species.

Comparison will now be made of the

Dorsal view of the skull of Mr. Stone's specimen. Here the resemblance to the robed and cowled monk is very plain. Note the shoulder and arm region, and at the top of the hood, the dorsal spine simulating a spear

two skulls figured in the dorsal aspect—those of Professor Eigenmann's specimen and of Mr. Stone's. If these figures are carefully studied, we are forced to the conclusion that they are of closely related species of catfishes. In shape, form, relative measurements, shape and position of the anterior fontanelles (dorsal apertures in the skull), these skulls are apparently identical. In only two respects are they different: Eigenmann's specimen seems flatter, Stone's more curved in the posterior dorsal region (i.e., over the arms); Eigenmann's specimen shows the notch posterior to the junction of the arm region with the skull forming a much narrower U than the similar notch in Stone's specimen. These differences are of course insignificant and of themselves are not sufficient to establish specific characters, but when added to the differences found on the ventral surface, we may be quite sure that the skulls belong to different species.

Comparison of all these various skulls in the ventral aspect reveals, first then, the similarity in that all have the crucifix plainly shown, since in all it is made of the same bones in the same relative position and arrangement. In the second place, the Weberian ossicles (forming the halo) are all practically identical. Finally, all have the "wing" bones (formed of the expanded lateral processes of the first vertebræ) alike in shape and position. However, on careful examination the differences are almost equally plain. The skull of the gaff-topsail (*Felichthys*) differs most widely from the others. It is broader throughout, but especially in the anterior region, where its divergence from the other skulls is most marked. Here also we have two long strands of bony tissue reaching forward and attached to the anterior part of the skull, and bearing a fanciful resemblance to a pair of legs—to carry the analogy still further.

Quite unlike the skull of *Felichthy* and unlike all the other skulls, is tha

of the smaller ocean catfish of our southern waters, *Galeichthys felis*. Here we have the cross, the halo, and the wing bones. The latter, however, with reference to the cross are at their outer ends differently placed and markedly unlike any of the others. Even more markedly different is the structure of the anterior part of the skull with its sharp, outstanding anchor-like points right and left, the laterally placed apertures in the roof of the skull, and the most anterior portion shaped like the "bitts" to which a cable is secured on a boat or wharf. Here, also, we have the "legs" previously noted in the skull of *Felichthys*.

Intermediate between these two is the Beebe specimen. This skull is relatively broad throughout but in front lacks the perforations found in the skull of *Galeichthys*. Also, it is not so wide as the *Felichthys* skull. Even more markedly intermediate is the anchor-shaped bone, the ethmoid, terminating the skull in front.

The other three skulls are very similar in general make-up and indicate that these forms are closely related. However, the absence of the tooth pads from the roof of the mouth sets off the Marshall specimens (four) and those of Dwight, Jommersbach and Farr as a separate species. Their presence in Stone's and Lang's specimens, establishes these as another separate species. With regard to Doctor Eigenmann's specimen the careful reader has probably noticed that it lacks the winglike bones extending out from under the halo. Wondering if this could be natural, since they are present in all the other skulls, I asked Mr. A. W. Henn, curator of fishes in the Carnegie Museum, to lend this skull to me. This he kindly did, and examination showed that these bones had been cut out, presumably to accentuate the crucifix feature, since without them this is somewhat plainer. To see this compare the figure of this particular skull with any other figure given herein.

We have here skulls from six species of catfishes all showing the crucifix on their ventral surfaces. It would be a study of considerable interest to collect a large series of skulls of the various ocean, estuarine, and fresh-water catfishes from all parts of the world and to ascertain how many and what forms have the crucifix. It would seem that this structure must be of considerable taxonomic importance. Further, while there has been some study of catfish skulls, there does not seem to have been any thorough study of their comparative osteology. These skulls are so widely different from those of other teleosts and in their relative proportions so different from each other, that such a study would be a very interesting even if an arduous and puzzling undertaking.

Apart from four or five isolated studies of various catfish skulls, none of which shows the crucifix, there are papers by two investigators in which studies have been made of the Weberian apparatus and of the hinder portions of the catfish skull. The skulls studied for these structures do not, however, contain crucifixes, and hence will not be considered here.

Historial data, additional to that quoted earlier, to form a background for the facts and fancies presented in this article, are almost wholly lacking. However, two brief accounts have been chanced upon referring to fishes other than siluroids.

The first citation is from Robert Blakey[1] who, in his delightfully chatty

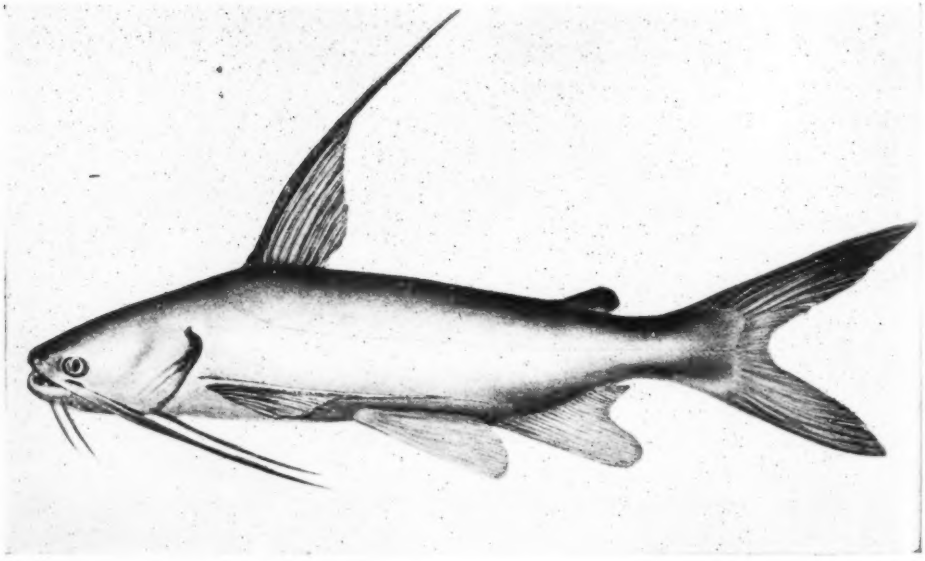
[1]Blakey, Robert. "*Historical Sketches of the Angling Literature of All Nations.*" London, 1856, p. 84.

book, says "The pike was long celebrated, in many parts of Germany and France, for its charms and medicinal excellencies. A little bone in the form of a cross, which is said to be discoverable in the head [i.e., skull] of this fish, was long worn by the credulous as a sort of talisman against witchcraft and enchantment."

In the year 1700 Michael Bernhard Valentini[1] published in Latin an article entitled "De virgine in sceleto funduli conspicua." In this he speaks of the figure of a woman plainly to be seen in the skeleton (i.e., skull) of a *Fundulus*, and says that certain bones imitate a form of dressing the hair common at the time. Now what the "*Fundulus*" fish was is a matter of conjecture only, but it was probably some member of the family Cyprinidæ, fishes common in central Europe. The "top knots" to which our author refers were probably the Weberian ossicles above referred to, the Cyprinidæ being fishes which, in common with the Siluridæ, have a well-developed Weberian apparatus.

Just what is meant by these two old accounts is not clear, but it is interesting to find the crucifix structure alleged to be present in the skulls of European fishes, and to find that the accounts go back as far as the year 1700.

[1]Valentini, Michael Bernhard. "De virgine in sceleto funduli conspicua." *Miscellanea Curiosa sive Ephimeridum Medico-Physicarum Germanicorum Academiæ Cæsario-Leopoldinæ Naturæ Curiosum.* Decuriæ III. Annus Quintus et Sextus, 1697 and 1698, (1700), p. 96.



A gaff-topsail catfish, *Felichthys felis*. This fish is not only interesting in that it has a crucifix on the under side of its skull, but also because the paternally-minded father takes the just-laid eggs into his mouth and there incubates them until they are hatched

Newts shedding their skins. From the life history exhibit of *Triturus viridescens*

The Department of Reptiles and Amphibians in the American Museum

By G. KINGSLEY NOBLE
Curator of the Department

MOST museum departments rise from small beginnings. Valuable material is received from expeditions, zoölogical parks, or private individuals. This must be cared for, perhaps studied, and later made known to the world both by publication and by exhibition. A custodian is found to supervise the care and study of the material. As time goes on he gathers about him additional material and other workers. Such museum custodians, or curators, as they are called, have been in most cases naturalists all their lives, and have lived and studied in museums long before they were employed by these institutions. A group of museum custodians and their collections are designated as a department. The history of a department is usually a record of successful expeditions, of increase of material, exhibitions, and publications. A department is like a tree branching out with time in every direction and from year to year adding distinct increments of tissue to the trunk which sustains the branches.

The department of reptiles and amphibians in the American Museum took root as a very small seedling sheltered by the department of invertebrate zoölogy. There was little exhibition and no publication, but several valuable collections were added to its store. Those of Dr. C. S. Allen from Florida and Colonel Nicholas Pike from Long Island were especially noteworthy. Miss Mary C. Dickerson's superb collection of batrachians, including nearly every species in the United States, was donated at this time. Expeditions sent by the Museum to Mexico, Porto Rico, Alaska, Patagonia, Egypt, and Siberia brought back reptiles and amphibians for the rapidly growing study collections. In 1906 a collection of approximately a thousand reptiles was secured by Dr. A. G. Ruthven in New Mexico and Arizona. In 1909 the department of ichthyology and herpetology was established. This led to the sending of expeditions primarily to collect reptiles and amphibians. The most important work was carried on in Santo Domingo, North Carolina, Mexico, and Porto Rico and, by 1910 the collections had been doubled several times. The exhibitions produced by this time had become recognized as some of the finest in the world. Several important monographs had been published. By 1919 it was deemed advisable to separate the departments of herpetology and ichthyology. The expeditions then sent to

Panama, Arizona, and Santo Domingo, devoted themselves more exclusively and hence intensively to the study of reptiles and amphibians. Today the collections number more than 60,000 specimens, and the researches based on this material form an imposing array of volumes. The tree planted nearly a quarter of a century ago has already borne much fruit.

A red-backed salamander, *Plethodon cinereus*, brooding her eggs. A new exhibit in the local series

The greatest achievement of the department during its long period of growth has been the establishing, under the direction of Miss Mary C. Dickerson, of perhaps the finest series of reptile and amphibian habitat groups ever produced. Of all vertebrate creatures, reptiles are perhaps the most difficult to reproduce in a lifelike manner. The "stuffed" lizards and crocodiles with their cracked and woefully distorted skins were soon replaced by mounts that looked startlingly like the living animals. It was in the construction of the several frog groups that Miss Dickerson displayed her real genius. These groups are still among the most admired in the Museum. Thousands of school children visit the Museum during the course of the year to study the groups illustrating the life story of the bullfrog, the tree toad, and other common Amphibia.

The hall in which these groups were installed was tenanted, from the beginning, by a whole series of cats and dogs, a great elephant, and an enormous "overflow collection" of other mammals. Many of these mammals were necessarily placed on top of the cases and draped in cheesecloth to keep off the dust. There they stood like the departed spirits of their more fortunate brethren within the cases. They cast a most ghostly atmosphere over the reptile hall.

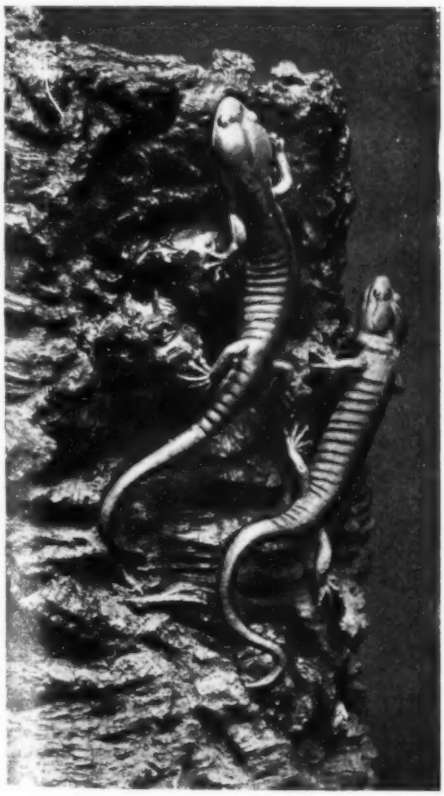
Fortunately, however, all this has now been changed. The entire third floor of the recently-completed east wing of the Museum will soon be

thrown open to the public as a new hall for the exhibition of reptile and amphibian life. In this hall there have been arranged not only Miss Dickerson's magnificent groups, but a whole series of new ones. The new exhibits include groups showing the habits of the Gila monster, the Galapagos land and sea iguanas, the giant tree frogs, the tuatara (*Sphenodon*), and certain sea snakes. Glimpses of some of these new groups are shown in the series of duotone pictures following this article.

Most exhibition halls of natural history are intended for a great variety of visitors: artists who come to seek the beautiful in the objects or scenes portrayed; naturalists who hope to find an answer to some question regarding the creatures they have seen in nature; biology students who expect to find illustrated in the most diagrammatic manner principles or facts with which they are engaged; and lastly the great mass of visitors who are merely interested in nature, or let us say in life, and wish to be informed in as many directions as possible. In our new hall we have tried to satisfy all these demands. The habitat groups are arranged in a cloister along the west wall of the hall. The visitor who wishes to study the groups in detail enters one of the cloister doors and leaves behind him all the systematic and "biological diagrams" which occupy the main part of the hall. The exhibition of local reptiles and amphibians has been installed in an alcove provided at the far end of the hall. Such an arrangement helps to keep the different types of exhibits as distinct units.

The greater part of the material

The Surinam toad, *Pipa pipa*, carries her eggs in pouches on her back until they hatch as fully formed toadlets. A model in the synoptic series



Arboreal Salamanders.—The California arboreal salamander, *Aneides lugubris*, spends most of its life in the trees. Its eggs are laid on land and the young salamanders never enter the water. An exhibit in the synoptic series

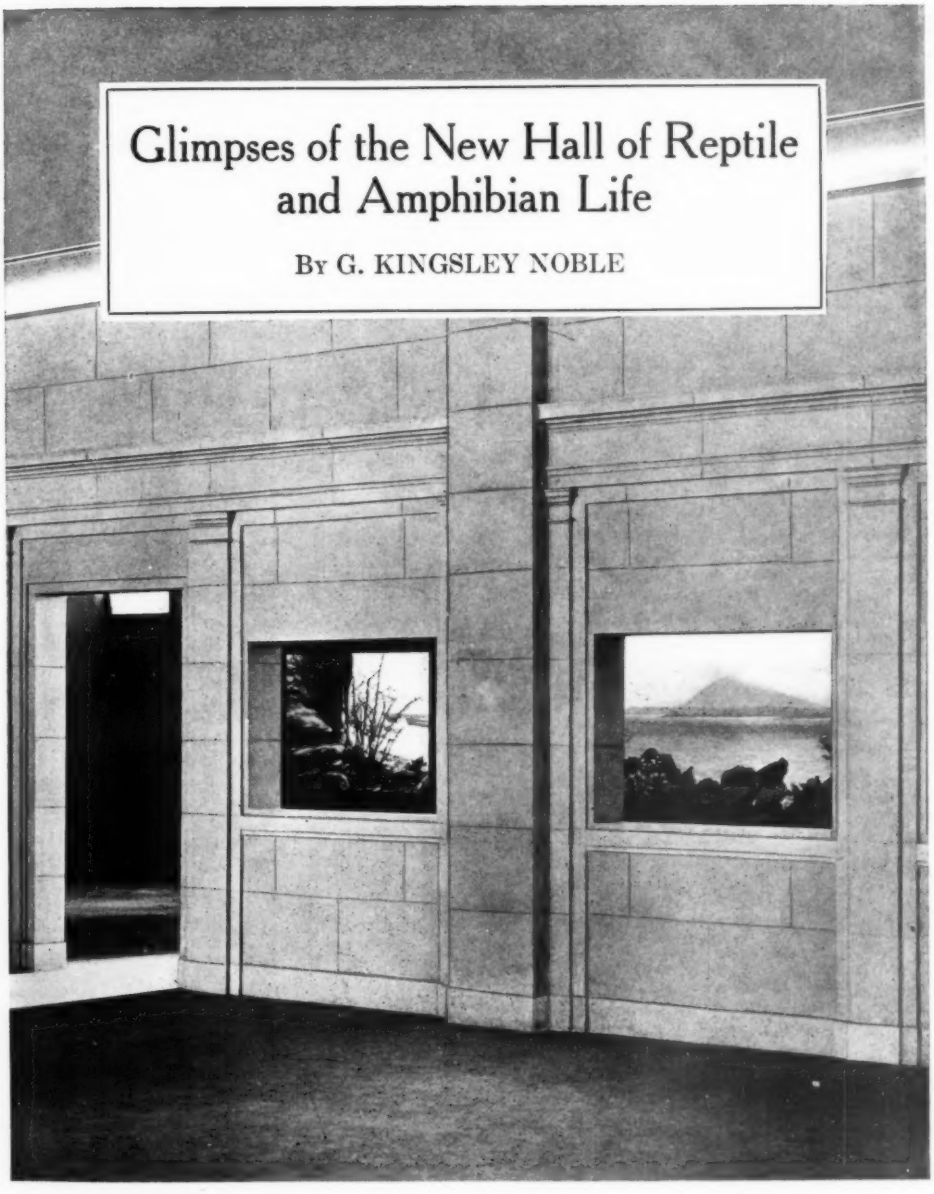
sent to museums is rarely placed on exhibition, but is filed away in what is called a study series. Such material is chiefly used in systematic or zoögeographic studies. It is also available for anatomical or phylogenetic researches. If specimens are captured alive they may be utilized in physiological or experimental work. Museums for decades have collected and described material, but as a rule, facilities for scrutinizing this material from all aspects have not been available to them. With the enormous strides which were made in all fields of zoölogy during the last decade the limitations of this macroscopic, descriptive method were all too obvious. The recent work on the endocrine system of Amphibia brings to our attention the existence of physiological species, forms which differ in their physiology if not in their structure. The occurrence of races of frogs differing enormously in their sexuality invites the museum curator with his great collections to take up the problem of sex determination. Botanists have already showed us that certain species and genera of plants have arisen suddenly by marked changes in the chromosome member. What is the relation of chromosomes to species in animals? This detailed and experimental method of handling museum specimens did not find a place in the schedule of the older museum workers, but it is being forced upon the modern curator as the only way of understanding his material. Amphibia have been recognized for a long time as ideal material for such experimental work. Some of our most fundamental advances in the biological field have been gained through the experimental study of these forms. The herpetologist cannot neglect these facts. The most primitive of all terrestrial vertebrates were amphibians. The great groups of birds and mammals sprung from the reptiles. Fundamental problems of anatomy, physiology, and phylogeny confront the herpetologist on all sides.

The department of reptiles and amphibians in the American Museum is at one and the same time a storehouse, a schoolroom, a bureau of information, a research center, and a source of educational and artistic exhibits. A secondary school may take the facts determined by research workers and present these to students, but a museum must work out facts and present them to elementary and advanced students at the same time. Museum curators are therefore confronted with the problem of keeping in the vanguard of biological research without losing their contact with the elementary students. How well the department of reptiles and amphibians has succeeded in this mission may be judged from a study of our new exhibition hall and an examination of our long list of publications.

The midwife toad, *Alytes obstetricans*. Synoptic series

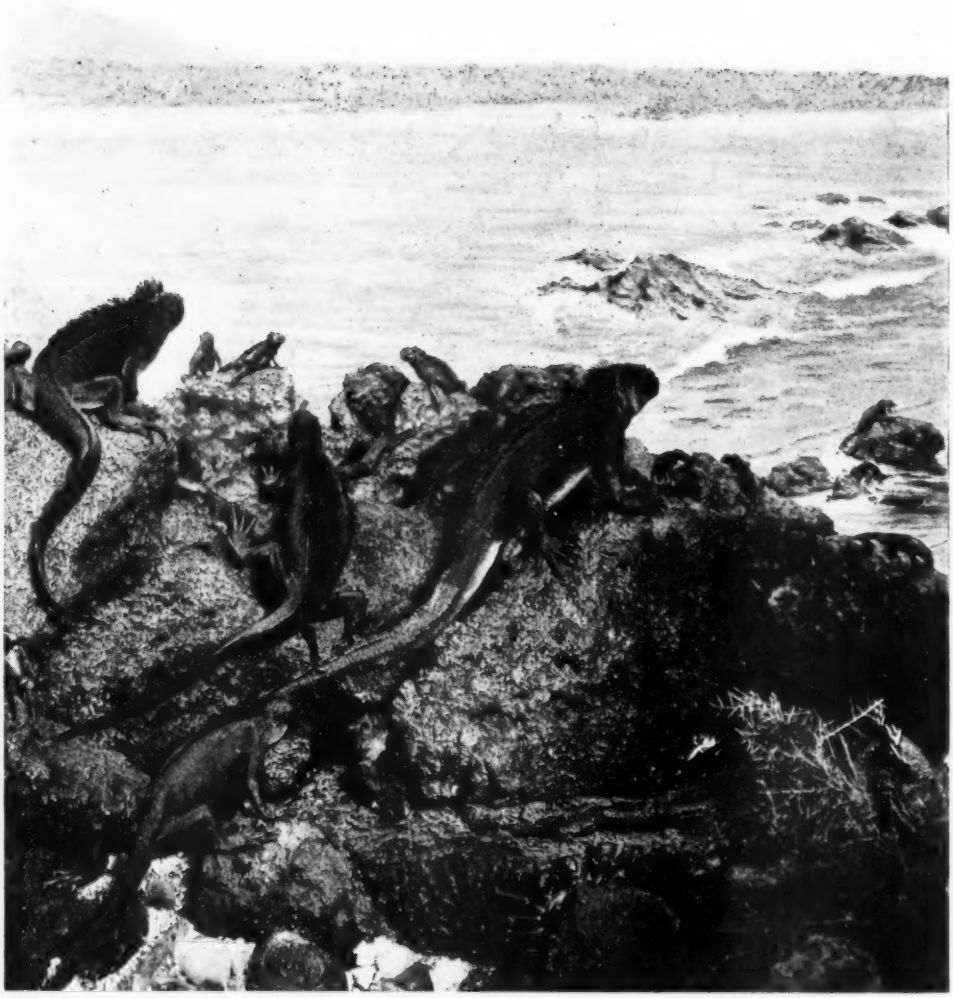
Glimpses of the New Hall of Reptile and Amphibian Life

By G. KINGSLEY NOBLE



THE APPROACH TO THE CLOISTER

The entire third floor of the recently-completed east wing of the American Museum will be devoted to the exhibition of reptile and amphibian life. A series of habitat groups have been arranged within a cloister along the west wall of the hall. Several of these groups are new and have not yet been shown to the public. NATURAL HISTORY has the pleasure of taking the reader for the first time through the new cloister and of pointing out a few scenes of special interest. Most of these views are of the new exhibits. The Lower California and the Galapagos Island groups may be seen above through two of the windows in the cloister. It is planned to open the new hall early in the coming year



MARINE IGUANAS

Grotesque forms in black perched on lava blocks overlooking the sea; a herd of Galapagos marine iguanas awaiting the falling tide to expose the algæ on which they feed. A detail of the new Galapagos Island Group.

The marine iguana, *Amblyrhynchus cristatus* is the only lizard in the world which feeds on seaweed, and is one of the few which are gregarious in habits. The eminent evolutionist, Charles Darwin, was the first to describe the habits of this lizard. The herds of marine iguanas are today much depleted, but fair-sized colonies may still be found on some of the islands of the archipelago. The materials for the group were secured by Mr. William Beebe, assisted by Mr. Walter Escherich, while they were members of the expedition made possible through the generosity of Mr. Harrison Williams. The specimens have been mounted by Mr. Escherich and the background painted by Mr. A. A. Jansen, working under the direction of Mr. James L. Clark

A NOONDAY SIESTA

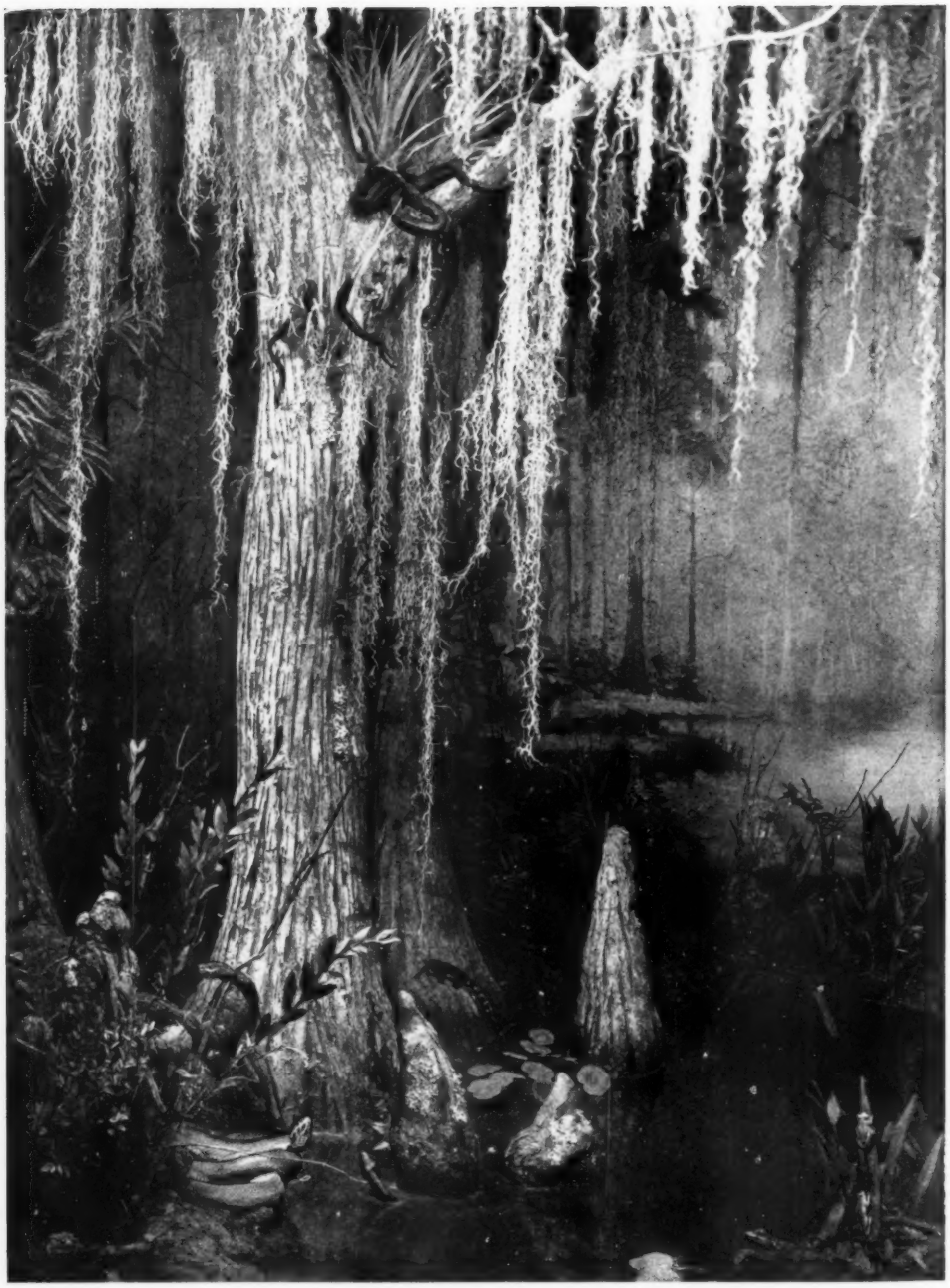
A marine iguana stretched out in the full glare of the sun to rest while a more ambitious companion in the distance has discovered a fringe of seaweed exposed by the retreating tide. A scarlet crab, *Grapsus grapsus*, has crawled from a damp crevice among the lava to see if any ticks are present on the lizard. Mr. Beebe found the crabs adept at pulling these tasty morsels from the reptiles' skins. A small detail from the Galapagos Island Group

OUT OF THE PAST

Iguanas with their scaly coats, powerful muscles, and sharp claws resemble the dinosaurs of old. A closer examination, however, reveals that they are essentially modern reptiles closely related to the Florida "chameleon" and "horned toad." The Galapagos land iguana, *Conolophus subscristatus*, unlike its relative and neighbor, the marine iguana, is strictly terrestrial, feeding on desert flowers, cactus fruits, and other vegetation. The alert creature portrayed above is one of the central figures of the Galapagos Island Group

A SECLUDED RETREAT

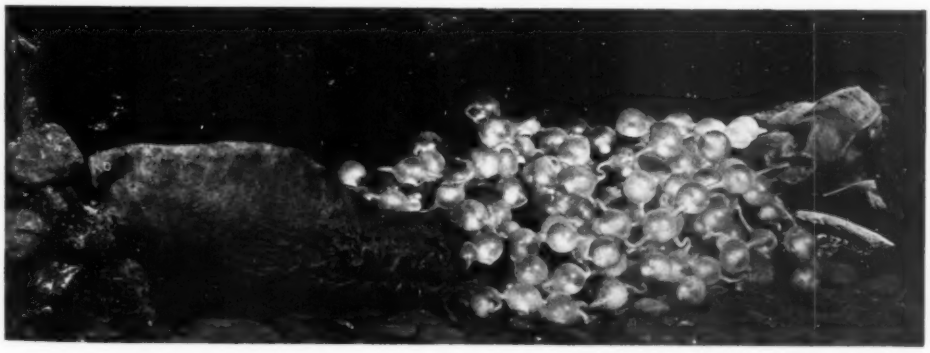
A Calapagos land iguana seeking what shade a xerophytic vegetation affords has plunged headlong into a scrubby thicket. The land iguanas of the Galapagos are not sociable, and rarely do two individuals seek the shade of the same tree. When two of them come together by accident, they are often pugnacious. One such reptilian duel was witnessed by Mr. Beebe. A detail from the Galapagos Island Group



AMID AISLES OF SWAYING TILLANDSIA

A cypress swamp and river cove of northern Florida in September, the home of the alligator, numerous turtles, lizards, snakes, and frogs. In this, the largest and last group built under the supervision of the late Miss Mary C. Dickerson, a whole array of biological facts are demonstrated. The life history of the alligator, the mimicry of poisonous snakes by non-poisonous species, the feeding habits of serpents, the variation with age in lizards and snakes, are among the features illustrated

The Giant Salamander Group.—A pool in a rocky stream in Pennsylvania showing *Cryptobranchus* feeding, fighting, and brooding its eggs



The dawn of parental instinct; a small section of the group.—The duty of guarding the spawn is assumed by the male *Cryptobranchus*, who valiantly defends his nest against all intruders. This worthy habit is not so altruistic as it would seem, for in guarding the nest the male protects his own food supply. Both sexes eagerly devour the eggs. Fortunately digestion is slow, and the male can eat only a small proportion of the eggs he guards. The greater number develop undisturbed, and the guarding habit is an advantage to the species

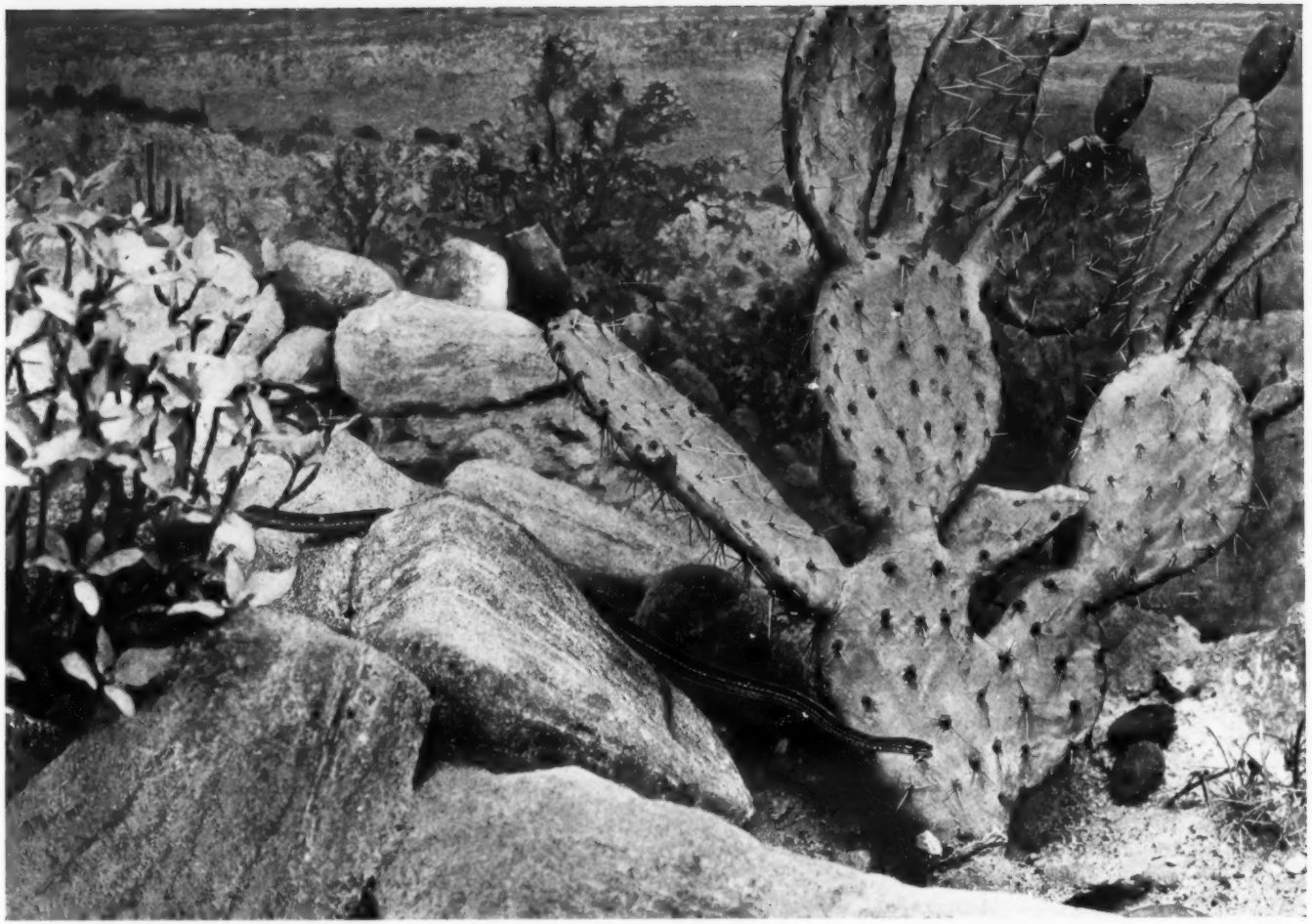
SUNSET ON AN ARIZONA DESERT

The new Gila Monster Group, illustrating the feeding habits of *Heloderma suspectum*.—The Gila monsters are stalking the lizards which have not yet retired for the night. One has spied a quail nest beneath a cactus and is about to steal the eggs. The accessories for this group were secured by Dr. A. I. Ortenburger and installed by the department of preparation under the direction of Mr. James L. Clark

secured by Dr. A. I. Ortenburger and installed by the department of preparation under the direction of Mr. James L. Clark

THE GILA MONSTER

In the evening the Gila monster, the only poisonous lizard in the world, emerges from its shelter among the rocks and prowls about in search of prey. A detail from the Gila Monster Group



A SNAKE OF THE DESERT

The sonoran racer, *Masticophis semilineatus*, glides rapidly over the rocks, seeking some favorite crevice for the night. A section of the Gila Monster Group

The Sonoran racer, *Masticophis semiannulatus*, glides rapidly over the rocks, seeking some favorite crevice for the night. A section of the Gila Monster Group

A DESERT DWELLER

Life in a waterless desert may seem impossible for a turtle, but the desert tortoise, *Gopherus agassizii*, selects these wastes of sand and thorn in which to dig a burrow and to pass a peaceful existence. A portion of the Gila Monster Group

Sunset shadows.—The band-tailed, earless lizard, *Holbrookia texana*, basking in the last rays of the sun, unaware of the presence of a hungry Gila monster. Detail from the Gila Monster Group

The fate of many a lizard.—The poison-channeled teeth of the Gila monster closed about a *Holbrookia*. Detail from the Gila Monster Group

The Life of the Red Salamander

By SHERMAN C. BISHOP
Zoologist, State Museum, New York

THE life history of an animal is sometimes pieced together from the scattered notes of many observers. Often, however, the discovery of some essential feature is the reward of long hours in the field over a period of many years. The red salamander (*Pseudotriton ruber ruber* Sonnini) is widely distributed and locally common in the east, and zoölogists have long been familiar with the adults and larger larvæ. Nothing, however, has been written concerning the eggs and early developmental stages, and conjectures on the breeding habits have been based on knowledge of related forms.

The brilliant coloring of the newly transformed salamander marks it as one of our most beautiful species. The ground color is a clear coral-red with numerous small, rounded black spots scattered irregularly over the back, head and tail. The belly and sides are lighter and comparatively free from darker markings. In some, the skin of the underparts is so transparent that the pulsations of the heart may be observed, and the position of the liver is indicated by an elongate brownish patch. But with all its brilliancy, this salamander never forces itself upon the attention, and one who finds it must search the clear streams and springs, or turn the logs and stones in cool ravines and swamps. It may be found at all seasons of the year, but in winter it is less active and hides beneath stones and rubbish below the surface of the water. If it wanders abroad, the venture is made during the warmer months, and at night, when there is less possibility of the skin becoming dry; for this species belongs to a group whose members are without lungs. The necessary oxygen is obtained through the thin, moist skin of the body and the membrane of the throat. Hence drying means suffocation.

The eggs of many of our common salamanders are deposited in the spring or summer, but those of the red are laid in the fall (in the north at least). The young hatch in early winter. The eggs of a single female may number seventy or more. They are attached to the under surface of stones buried deep in the bed of a spring or stream, where they may be bathed in the coolest waters. The individual eggs, enclosed in gelatinous envelopes, are suspended on slender stalks, which flatten out at the point of contact with the stone to form an attachment disk. The eggs are clustered in little patches of a dozen or more, and the entire complement may cover an area several inches across.

As the young embryos develop, they gradually take on some semblance of the adult form. The more evident changes are those which involve the molding of tissue to form the head, trunk, and tail. Then the development of the gills and fore legs may be observed, and the first blush of color other than that imparted by the yolk. The gills and legs appear first as simple budlike projections; but development is fairly rapid, and the buds elongate to form, in one instance, the delicately fringed gills, and in the other, the legs with their slender toes. The hind legs develop more slowly than the fore. In

Photograph by S. C. Bishop

The home of the red salamander.—The red salamander frequents the springs and brooks of our northeastern states. At the base of the Helderberg escarpment in Albany County, New York, many such springs bubble forth and furnish hiding and breeding places for both red and purple salamanders

this respect the salamanders differ from our common frogs and toads.

At the time of hatching, the young salamander is scarcely half an inch long. It is endowed with stubby legs and small gills, and a belly full of yolk to carry it through the first few months of its existence. The mouth is rudimentary and incapable of functioning, the eyes are indicated by pigmented spots, and the tail is provided with a broad keel. At this stage the tail is the most important appendage, for it serves in the wriggling process which enables the larva to make its way under the stones and rubbish of the spring bottom. Here, through the cold months, it may rest almost inactive, developing its eyes and legs and mouth at the expense of the yolk, and acquiring the color and other characteristics of its kind. The yolk is lighter than the other body tissues and its buoyancy often as not turns the larva upside down.

In the early spring following the winter period of relative inactivity, the young salamanders acquire a new interest in life. The yolk which sustained them has been absorbed, and they are forced to undertake foraging expeditions of their own. At this time

the food consists largely of water fleas (Entomostraca) and the smaller worms and larvæ of insects, which are captured by quick, sidewise movements of the head. The feeding grounds are likely to be thick beds of cress, Chara, or other water weeds. To salamanders only an inch in length they are veritible jungles. Here the nymphs of dragon flies and beetle larvæ lie in wait and accept young salamanders as delicate additions to their diet. Newly hatched larvæ scarcely resemble the adults in color, for at this period the body has scattered fleckings of brown and black over a dull white ground color. This is a transient stage, however, and as the larvæ grow, the color becomes brighter and the spots more prominent. The ground color gradually changes from dull white to brown.

To determine the length of the larval period, it is necessary to measure a considerable number of specimens taken at approximately the same time of the year. When selected according to size, they will form groups which will in most cases, indicate the annual

Photograph by E. J. Stein

The eggs of the red salamander.—The female red salamander attaches her eggs to the under surface of stones in springs. The eggs shown above are in an advanced stage of development. Photographed under water. Slightly enlarged

Photograph by S. C. Bishop

THE RED SALAMANDER

The old red salamanders lose the bright coral-red color of youth and become considerably darker with age

increments of growth. In the case of the red salamander, the larvæ which hatch in November reach a length of about one inch by April or May. Other salamanders collected at this time of the year will measure about two inches in length and represent the growth of eighteen months. The largest larvæ will have a length of four inches or more and be about thirty months old.

The most distinctive features of the larvæ are, of course, the gills. The broadly keeled tail is also a character which, in the red salamander, reaches its best development in the larvæ. As the time for transformation approaches, the larvæ gradually lose their juvenile characters and take on those of the adult. The brownish ground color gradually becomes red, the gills shrink to mere stubs, then disappear, and the tail becomes more rounded as the keels are absorbed.

These striking external changes are accompanied by others as important to the animal but much less conspicuous. The teeth, the lips, and the tongue, are involved in the changes which transform a strictly aquatic larva to the adult capable of living on land or in the water. How long the bright coral-red of the newly transformed individual is retained is a question not yet answered, but it is certain that the animal is fully adult in this stage, for specimens have been found with mature eggs.

Those who are acquainted only with the brightly colored form would scarcely recognize the individuals which have taken on the more somber colors of age. The rounded black spots spread and fuse and richer tones of purple and brown replace the coral red. Small flecks of pigment spot the lower sides and venter and the lower lip may bear a narrow band of black.

The adult salamanders are not usually social in their habits, but occasionally several will share the same small spring, and two may sometimes occupy a hollowed-out retreat beneath some log or stone. Worms, insects, and other salamanders are the chief items in the diet of the adult. They feed readily in captivity and thrive on earth worms and bits of fresh meat.

The full-grown salamander may measure six inches in length, but many are smaller. In fact some adult specimens are considerably shorter than the largest larvæ.

The enemies of this salamander are many and its life is constantly threatened from egg to old age. The eggs are sometimes eaten by other salamanders and are destroyed by fungi and molds. The young larvæ are the prey of older members of their kind and of aquatic insects. The adults may serve to eke out the meal of an owl.

This, in brief, is the history of one of our common salamanders near the northern limits of its range, one whose life story was previously not known. Further study of the salamander in regions farther south and the discovery of additional egg masses will doubtless show that the period of egg-laying extends over several months, and that the time of laying is more or less controlled by the temperature of the water.[1]

[1]Mr. M. K. Brady, of Washington, D. C., has informed the writer that females dissected in December had mature eggs in the ovaries and that he found a batch of eggs in the field on February 10, 1915.

THE MARAUDER OF BITTER GUANA CAY

The natives of this Bahaman isle were forced to abandon their homes because of the depredations of the iguanas. Here one of the marauders is shown hesitating before approaching the bait of dried fish placed in the open by the camera man

The Iguanas of Bitter Guana Cay[1]

By ALFRED M. BAILEY
The Colorado Museum of Natural History, Denver, Colorado

OFF the Florida coast lie the Bahamas—small coral islands set apart from the mainland by a deep channel of the Atlantic, with its ever-flowing, warm Gulf Stream. They are an ideal spot for a month's cruise over shallow waters, with their gleaming sands reflected in a myriad of colors, extensive coral reefs, interesting invertebrates, and wealth of fishes. The wild life is varied, and a collector finds himself in a new world, seemingly. Native houses of coral rock glisten in tropical settings of coconut palm, palmetto, and fields of sisal. Bands of genial colored folk welcome the stranger to their out-of-the-way homes.

We had been collecting for the Colorado Museum of Natural History along the small islands making up the Exuma Chain, working as far south as Seal Cay. Many of the dark-skinned people had spoken of the "guanas" on Bitter Guana Cay, and I had promised myself a few hours ashore there on the return trip toward Nassau. After finishing my work on Seal Cay, we turned northward and crossed the deep channels between the various islands, our little gasoline launch "Friendship" rolling like a barrel in the big swells.

The weather had been blustery in the early morning, with intermittent rain squalls, and a waterspout came uncomfortably near, traveling slowly with the wind. It was a relief when, toward noon, the wind dropped, and a "slick calm" prevailed. We pounded on over the shallow waters of the extensive banks, and never have I seen such a dearth of life, even in arctic Alaska. An occasional barracuda took our spoon trailing aft, and two small sharks cruised inquisitively alongside for a while, but the bottoms seemed curiously clear—just great expanses of sand, and not a bird dotted the sky.

We dropped anchor that night at Farmer's Cay and visited the settlement there. Next morning, as the sun lighted the topmost leaves of the palms, we were on our way to Black Point Village, on Great Guana Cay. We found this little town a picturesque and pleasing place, with native boats tugging at anchor in the harbor, or pulled up on the shining beaches. The whole village offered to show me the "guanas," so, after choosing two men, we were soon on our way.

Bitter Guana Cay proved no different than the many other sandy-beached coral rocks so numerous in Bahaman waters. A rather high hill of pure white wind-blown sand, gleamed in the semitropical light, the heights crowned with the same dense, impenetrable thicket of wiry bushes. Huge cacti and prickly pear projected over deep water along the ocean front. A few laughing gulls and royal terns explored near-by waters, and a band of man-o'-wars, mere dots high up against the blue, sailed on motionless wing. Altogether, it was a delightful spot.

Our barefooted guides led the way over the needle-like rocks, even those leather-footed boys walking gingerly until they reached the drifted sand. Scarcely had we reached shore when we saw our first iguana, a large one about three feet in length, high up in a bush, with his head and fore legs silhouetted

[1]Photograph by the author

The eroded and pitted limestone of the Bahamas affords innumerable subterranean retreats into which the iguanas can escape when hard pressed by the natives

A young iguana working its way under the palmettos peered inquisitively at the intruders

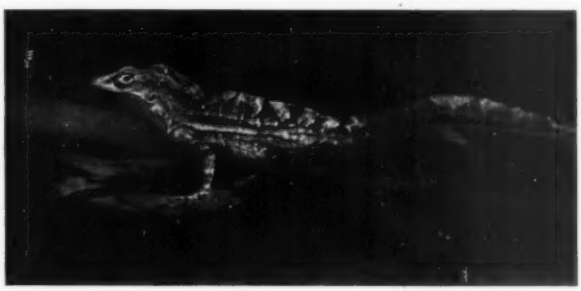
against the horizon. He was a weird-looking fellow, and it was not difficult to imagine him magnified many times, and thus to envisage what primitive man, if he had existed then, might have seen in the days of the dinosaur.

We worked along an open sand ridge and occasionally caught a glimpse of other iguanas as they scuttled from our path into huge, crater-like holes in the solid coral rock. The iguanas were not wary, however, and I had no difficulty in securing a few specimens for our habitat group. The vegetation was so thick it was next to impossible to secure pictures, so we tied a piece of dried fish in an open space, and on our return an hour later, found a grand old fellow waiting to be photographed. As I maneuvered for a clear view, a young iguana scarcely a foot in length worked his way from the débris at the base of a palmetto and peered inquisitively as his portrait was added to the collection.

The natives value the iguana highly for food. They told me the animals were easily caught in baited crayfish pots. They have made a practice of killing them for years, but there is apparently no decrease in the number. That these lizards are able to hold their own is demonstrated by the fact that the blacks have endeavored to farm a portion of Bitter Guana Cay and were unsuccessful because the iguanas ate the crops, this in spite of all the precautions the natives could take. The farmers finally abandoned the island in favor of the iguanas.[1]

A Bahaman home

[1]The iguanas collected on this trip were new to science and were described by Dr. Thomas Barbour in the *Proceedings of the New England Zoölogical Club*, Vol. VIII, pp. 107–09, and named for Mr. J. D. Figgins, Director of the Colorado Museum of Natural History, Denver, Colorado.



A Bahaman "chameleon" investigates. *Anolis* is everywhere abundant in the Bahamas. Dozens of bobbing heads greet the visitor to these isles

THE ANACONDA

The anaconda, *Eunectes murinus*, is the largest serpent in the New World, and is second in size only to the reticulated python of the Malay region. It may reach a maximum length of thirty feet. Snakes more than thirty-five feet long exist only in the imagination

Big Snakes in Captivity[1]

By W. HENRY SHEAK
Lecturer on Natural History Subjects

THERE is a common popular belief that every big snake is a boa constrictor. This is far from the truth. The typical boas are confined to tropical America and fall far short of some of the Old-World pythons in both length and weight. As a matter of fact, the boa constrictor rarely exceeds twenty feet in length, and one twelve or fifteen feet long may well be considered a large specimen. Most of them fall below these figures. The "tree boas" are smaller still.

The largest member of the true boas (Boinæ) is the anaconda (*Eunectes murinus*), an arboreal and aquatic species, well adapted to life along the rivers of South America. The largest preserved specimen known to scientists is a skin twenty-nine feet long in the British Museum, but thirty-foot specimens have been recorded. It is probable, however, that the average length is nearer twenty feet. Probably the largest anaconda ever shown alive in the United States was one exhibited a few years ago in the New York Zoological Park. It measured 18 feet, 6 inches.

The showman knows full well that most people are looking for a monster in size when he exhibits a boa, so he is going to show them a *big* snake for a boa. Consequently, in most traveling menageries, the gigantic pythons of Africa and Asia are represented as "boa constrictors." Aside from the greater size to which they attain, and their distinctive markings, the pythons differ from the boas in certain skull and scale characters.

The largest serpent known to science is the reticulated python (*P. reticulatus*), sometimes known as the royal or regal python on account of its very great size, sometimes as the rainbow python from the rainbow-like tints seen on the scales in certain lights, especially immediately after shedding the skin. It sometimes attains a length of more than thirty feet, and specimens measuring from twenty-five to twenty-nine feet are by no means uncommon. This is the most beautiful of the big snakes. It is a native of Siam, Sumatra, Burma, Borneo, the Philippines, the Malay Peninsula, and some of the East Indies.

The pythons, like all the other snakes, shed their skin periodically. The interval between molts depends upon the age of the snake, whether or not he is growing rapidly, his health, and the temperature in which he is kept. A young snake growing rapidly will, of course, shed much more frequently than an older one growing slowly, or not growing at all. The skin does not expand with the growth of the body, and must be shed and replaced by a larger integument, or growth is impeded. A snake in poor health will, at least sometimes, shed oftener than one in good health. A snake kept in a high temperature will shed more often than one kept too cold. Our small native American snakes frequently creep out of a skin and leave it entire, and this may be true of the pythons in a state of nature, with the normal amount of exercise; but in the close confinement of the cage the skin generally comes off in frag-

THE ANACONDA

The anaconda, *Eunectes murinus*, is the largest serpent in the New World, and is second in size only to the reticulated python of the Malay region. It may reach a maximum length of thirty feet. Snakes more than thirty-five feet long exist only in the imagination

[1]Negatives of illustrations used in this article are the property of the New York Zoological Society, and NATURAL HISTORY is indebted to the Society for the use of the prints.

ments and usually not without assistance from the keeper. Never during my connection with the Edwards' Animal Show, have we succeeded in taking a skin entire from either the rock python or the reticulated, but often have been successful with the Indian. This required time, patience, and labor. The snake was put in a bath of warm water for ten or twelve hours, after which four or five keepers held the reptile while one of us spent three or four hours carefully stripping the delicate skin from the body. Mr. Edwards donated several of these skins to different scientific institutions. This "skin" is, of course, not the true skin, but only the superficial layer of the epidermis, and is thin and fragile. The true skin, out of which ladies' belts, pocketbooks and the like are made, can be obtained only after the death of the reptile, as in the case of any other leather.

There is a widespread belief that snakes must be kept on ice. On the contrary, it is necessary to keep them warm, and this is especially true of the tropical species. If, for the latter, the temperature sinks much below 70° F., the food will not digest, but will ferment in the stomach. I have seen a big reticulated python swell to nearly the size of an old-time beer keg, as a result of getting cold after a heavy feeding. With the Edwards' menagerie we had oil heaters on all the python dens. Another persistent belief is that the big snakes are drugged—"doped," to use the common vernacular. I have never known a keeper or "charmer" to use any kind of opiate. Big snakes are naturally sluggish.

There is nothing in man's or woman's ability to "charm" snakes. No snake has enough intelligence to discriminate one person from another. The only secret is in treating the snake with kindness and accustoming it to being handled. Neither is there anything in a snake's ability to "charm" birds or other creatures. It is said that most creatures, including man, are born with a fear of snakes. Experiment, however, has proved this to be untrue. Many birds flutter before snakes merely to attract them away from their nestlings.

The forked tongue of the serpents, so often protruded, is not a "stinger" as many people suppose. It is perfectly harmless and possessed by the non-poisonous as well as the poisonous species. It is merely an organ of taste, but possibly so well equipped with sense buds that it can detect odors in the air.

None of the boas or pythons are poisonous. They will bite, and bite savagely, but the bite is not poisonous and usually heals quickly, as there are no decaying food particles on the teeth to produce blood poisoning. The teeth are used to catch and hold the prey, not to masticate it. Hence they are simple and smooth in structure. They are pointed backward, and when a snake closes his jaws on any creature, it is next to impossible for that creature to get away. Should a big snake ever catch your hand, do not attempt to pull away from him, as that would only drive the teeth deeper into the wound, but push your hand down his throat. This will make him let go. It is a mistake to think a snake *cannot* let go. I have seen them let go and disgorge at any stage of the process of feeding. They seize the bird or mammal with the teeth wherever they happen to strike, throw one or more coils about it and crush it till it is dead. Many of the smaller snakes swallow their prey alive but the big constrictors always kill it.

Something to frighten the timid.—The anaconda's eyes lie nearly on the top of the head, for the creature is a river snake and must look up as well as around in search of prey

A forty-pound pig, or even a five-pound chicken, alive, would prove too active and uncomfortable a morsel for the stomach of even a thirty-foot python. But it is a mistake to think they crush the bones or reduce the prey in size. The constriction is merely for killing. They may break the ribs, but that is only incidental. When the victim is dead, they take it by the head and begin swallowing. Now and then a snake will unwisely begin to swallow at some place other than the head, but unless the prey be very small for him, he will fail to get it down.

They do not cover the food with saliva before beginning to swallow it, but it is moistened and lubricated by a very copious flow as it enters the mouth and passes down the throat. They are capable of swallowing prey at least four times the normal diameter of the throat. The articulations of the jaws are very loose, and the connecting tissues of the two halves of the lower jaw are very elastic. I have seen the anterior ends of the lower jaws separate nine or ten inches in a large python when feeding.

There are many marvelous stories concerning the swallowing capabilities of these great serpents. There is no doubt in my mind but that a twenty-five- or thirty-foot python could easily crush and kill an animal the size of a horse or ox. The constricting powers are almost beyond belief. In feeding,

sometimes one has wrapped its tail about my ankle, and it was necessary for me to take both hands and use all my strength to uncoil just the tail. A man who had been a soldier in the British army in India, told me he once saw a big python coil about a horse. The ribs snapped and the horse dropped dead almost instantly. But no snake could swallow so large an animal. I see no reason, however, why one of these monsters could not swallow an ordinary man. Carl Hagenbeck, from whom we purchased the big reticulated python known as "Long Tom," measuring a trifle more than thirty-two feet in length, an unusually fine vigorous specimen, declared he had a photograph of this snake swallowing an Indian antelope weighing sixty-seven pounds. When in our possession, "Long Tom" swallowed a pig weighing forty-five pounds.

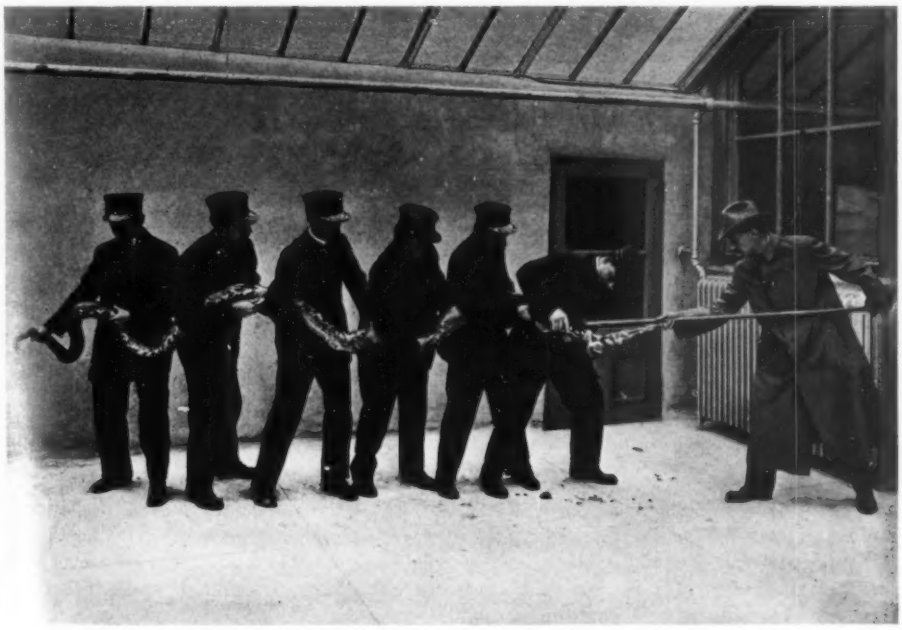
But these monsters rarely attack man or the larger mammals; in fact they never do so unless they are provoked or molested. They confine their depredations to animals that they can swallow without much inconvenience,—birds, and mammals weighing from about twenty-five to forty pounds, or considerably less. When captured, one of these snakes will fight most savagely and is likely to smash almost anything that offers resistance. But he fights because he is afraid he will be hurt. When he learns man is his friend, he becomes gentle and usually remains so. Now and then, however, a specimen continues mean.

It is erroneously supposed that these big snakes will not take anything but living prey. It is probably true that in a state of nature they will not eat anything but what they themselves kill. But after they have been in captivity awhile and have become accustomed to being handled, and to taking food from the hand of man, they will learn to take their prey after it has been killed for them. When we feed them in public, we always kill the prey before offering it to the reptile. We dangle the bird or mammal before the eyes of the serpent. He thinks it is alive, coils about it in the belief that he is killing it, and then swallows it. In fact, we have fed to our snakes rabbits killed in Australia and shipped to America in cold storage. However, they are very particular as to the condition of the food. If it be the least bit tainted, or the fur or feathers bear the least bit of foul matter, or they bite into the sour crop of a chicken, they will drop the prey and refuse to take it again. I have known a snake to vomit from tasting something foul. The sense of taste, as well as that of smell, is very acute.

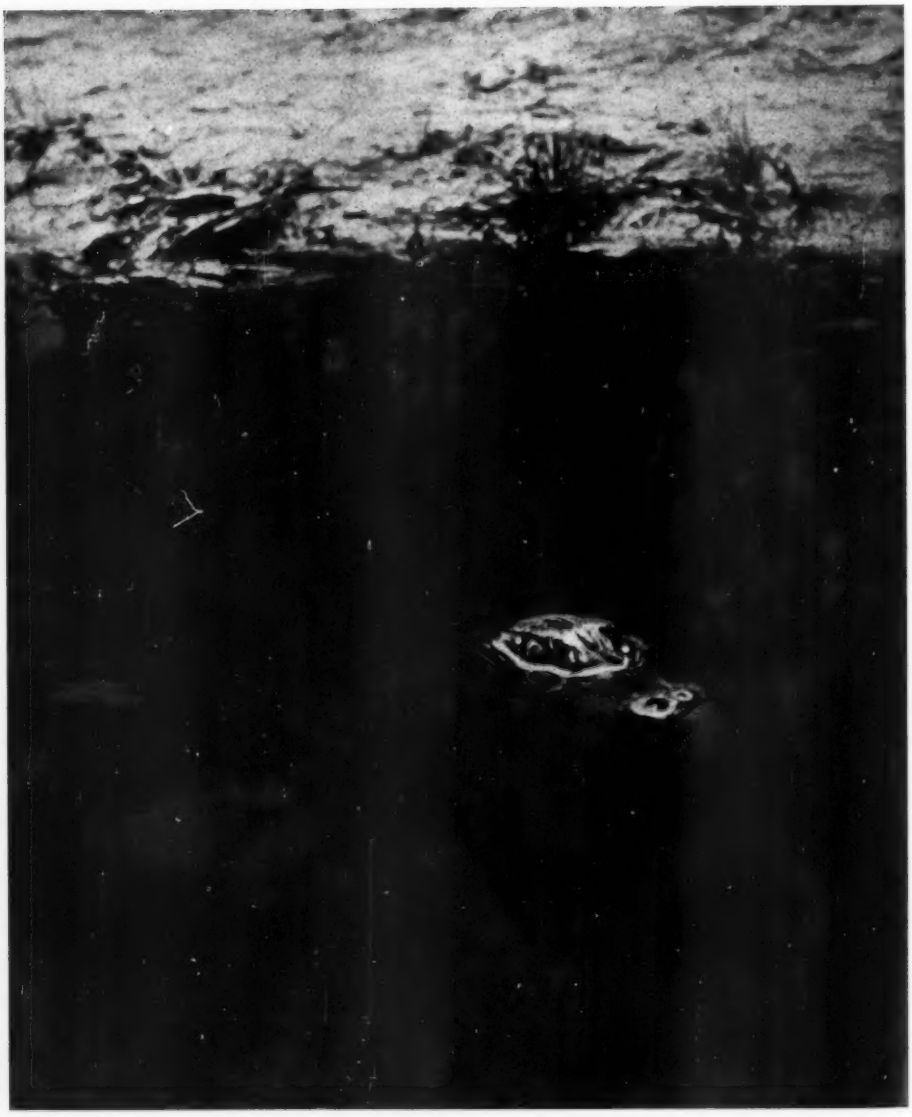
When one of these great pythons has been fed all he cares to eat at a meal, from five to seven large chickens or rabbits, he will not eat oftener than once about every seven to ten days. In order to get snakes to eat more frequently, that is, to provide a daily exhibition of feeding, we would give them but one chicken or rabbit at a time. In this way we could get them to eat at much shorter intervals. We once fed a big Indian python five times in two days. It requires from five to seven days for the food to digest. The bones are digested, but not the hair or feathers or any grain that may be in the crop of a chicken. During the process of digestion the snakes are extremely sluggish, lying coiled in a heap most of the time. When they are hungry, they become more active and move about, often with the head raised a considerable distance above the ground. Some snakes have been known

to live from one to two years without feeding.

It now and then occurs that one of these big snakes refuses to feed in captivity. This is particularly true of the reticulated python. Not that he deliberately makes up his mind to starve himself to death, for no snake has intelligence enough for that; but the long sea-voyage to America and the conditions of captivity take away the appetite. What do we do in a case like this? Sometimes we can save them, even bring back the appetite, by injecting into the stomach eggs beaten into milk. This is done by means of a rubber tube. Some menagerie men force guinea pigs or rabbits down the throat of a snake that has gone on a hunger strike. We used a similar treatment. We took a piece of calfskin, fresh from the calf, and, with the flesh side out, sewed it together in the form of a tube about two and a half feet in length and four inches in diameter. This we stuffed with beef and ox-tail, or other pieces of bone, making a huge sausage. When all was ready, the sausage was fastened to the end of a twelve-foot section of gas pipe, the reptile was taken from the cage, held straight by from eight to twelve keepers, and the sausage thrust down his throat. It was heroic treatment! Occasionally a reptile was fatally injured in this way, but usually the operation was successful. In some cases, after forceful feeding once or twice, the appetite would come back and the snake would begin taking nourishment in the normal way.



The end of a hunger strike.—Mr. Ditmars and several keepers at the New York Zoological Park engaged in feeding a rabbit to an obstinate inhabitant of the Zoo



EYES OF RED FIRE

The alligator floats with only eyes and nostrils above the surface. In this position it can see without being seen. At night the eyes, reflecting back the light of the headlamp, shine like two flames of red. Alligators are usually afraid of man and the fiery eyes vanish at his approach. On one occasion they did not disappear. What would you do if attacked by an alligator in a swamp at night?

The Tale of "Old Fire Eyes"

AN ENCOUNTER WITH A GIANT ALLIGATOR IN THE SWAMPS OF LOUISIANA

By PERCY VIOSCA, Jr.
Southern Biological Supply Co. Inc., New Orleans, La.

I DOUBT if anyone has ever seen "Old Fire Eyes" by daylight, and few indeed are they who have had dim visions of her fleeting form in the blackness of night. Nothing is known of her pedigree or her age, and even her sex is a matter of conjecture, although her femininity might have been presumed because of the very question of her age. Even her size can only be surmised, and her whole life history is enshrouded in the darkness and seclusion of her chosen haunts. In strong contrast to her surroundings is the brightness of her eyes, for no dragon of an older day could boast such orbs of red flame. Few indeed are they who have looked into those fiery eyes, but I am one of them, and in those fleeting glimpses, I have gathered the story of her life.

Fringing the north shore of Lake Ponchartrain between Mandeville and Lewisburg, Louisiana, lies a strip of wooded swamp land, which, in its primitive state, was heavily forested with tupelo gum and cypress. The arched branches, draped with Spanish moss, met overhead, shielding the darkly tinted water below from the direct rays of the sun. To one not inclined to appreciate the beauty of such surroundings, it might truly be called a dismal swamp. The whole area, approximately two miles long by one-quarter mile wide, is bordered in the rear by the virgin pine forests of the coastal plain,—on the front by the waters of the lake, from which it is separated by a sand ridge and beach only a few yards wide. It was in this virgin swamp that "Old Fire Eyes" must have chased her first minnows and crayfish among the cypress roots as she began to learn the ways of her kind, for she had been destined to begin life as a baby alligator.

As alligators are chiefly nocturnal in their habits, it was not paradoxical for her days to be brightened by the darkness of her surroundings, and the first real darkness came into her life with the cutting of the marketable timber. She soon came to distrust Man, and her survival is proof that with age came wisdom. Only during the hours of darkness did she find complete safety from the lead-spitting weapons of her greatest enemy. But Man in his greater wisdom came to learn that a light worn on his head makes the eyes of all nocturnal creatures shine in the dark. One by one she learned to elude these devices, the pine torch, the coal-oil headlamp, the brilliant acetylene searchlight, while her less wary brothers and sisters were converted into pocket books.

My first knowledge of "Old Fire Eyes" dates back about fifteen years. While camping in the vicinity of her swamp during my college vacation days, it was customary for our party to "shine" frogs whenever our meat or fish supply ran low. Occasionally tenderloined alligator tail varied our menu.

On these midnight raids, made primarily to satisfy the inner man, it was soon discovered that we had in our headlamps a powerful instrument for the study of natural history. The eyes of all of the larger nocturnal creatures, and even many of the smaller, reflected bril-

Photographs by the author.

IN THE DEPTHS OF THE SWAMP. CYPRESS AND TUPELO GUM ARE THE DOMINANT TREES OF THIS AREA

IN THE DEPTHS OF THE SWAMP. CYPRESS AND TUPELO GUM ARE THE DOMINANT TREES OF THIS AREA

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THE EDGE OF LAKE PONTCHARTRAIN WHERE THE HUNT BEGAN. DWARF PALMETTO AND SCRUB OAK MAKE TRAVELING DIFFICULT

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liantly the light of our headlamps. We soon came to recognize the different creatures, often at a distance, by the color of their eyes, and many were even fearless at close range with the light flashed fully upon them. The bullfrog, with its eyes of opalescent green, was more easily approached, and we soon came to bag a high percentage without the use of a gun or other device. The eyes of alligators shine a brilliant ruby red. From time to time we took an occasional specimen, for mascot or for meat, from the Mandeville swamp.

On some of these trips we would catch glimpses, at perhaps a hundred yards, of a pair of rubies much larger than the rest, or again we would see a single ball of fire darting across the surface of the swamp to vanish into the night. Tree trunks, stumps, logs, cypress knees—none were an impediment to this orb of red fire. For several successive summers the same thing was observed. We realized then that we had in that swamp a monster that defied every instrument civilized man had contrived for its extermination.

In the course of time my natural-history studies took on a more serious turn. During an investigation into the habits and distribution of the southern bullfrog, *Rana grylio,* which I found to be a co-habitant in parts of this state with the common bullfrog, *Rana catesbeiana,* I was to become more intimately acquainted with "Old Fire Eyes." One night during the summer of 1917, I set my course for the Mandeville swamp in the motor boat "Amœba," my only companion being a young friend whom we nicknamed "Leech," not because of his stick-to-itiveness, but because his bare legs proved to be a great attraction for those annelids. A dry squall from the southeast made the lake uncomfortable, and as it was risking the boat to enter shallow water because of cypress stumps in the lake at that point, we attempted to seek refuge at about 11 P.M. in the canal of a lumber company near Lewisburg.

Having brought the "Amœba" to safe anchorage, we entered the swamp armed only with headlights and flour bags. Locomotion was as good as could be expected in eighteen inches of water studded with cypress knees and strewn with all manner of logs and branches, some afloat and some waterlogged. We could not operate to advantage near the lake, because the strong wind there made the lights flicker, and since best results are obtained when collectors separate so as not to cast the rays of their lights on each other, "Leech" went toward the rear of the swamp and I remained nearer the middle.

Collecting conditions were almost ideal, and by 1 A.M. I had bagged about as many frogs as I could carry. Three species were represented, the two bullfrogs, *Rana catesbeiana,* and *Rana grylio,* and the smaller swamp frog, *Rana clamitans.* "Leech" had made a good catch, too, but about this time was having trouble with his light, which needed a fresh charge of carbide. Unfortunately, the latter was in my pocket, and "Leech" had begun to make his way slowly toward me when his light suddenly went out. In those days we did not carry pocket flash lights for such emergencies and he was left in a blinding darkness.

In the meantime, not knowing of "Leech's" predicament, because we were out of earshot, I had decided to make my way toward the beach to rest while waiting for him to finish his hunt. During the night I had seen a number of alligators of sizes varying

from one to four feet. Some were wary, others more easily approached, while others had to be kicked out of the way. "Old Fire Eyes" had not been sighted, and I imagined she had seen us first. No attempt had been made to catch any alligators, as it is not wise to put them in the same bags with the frogs.

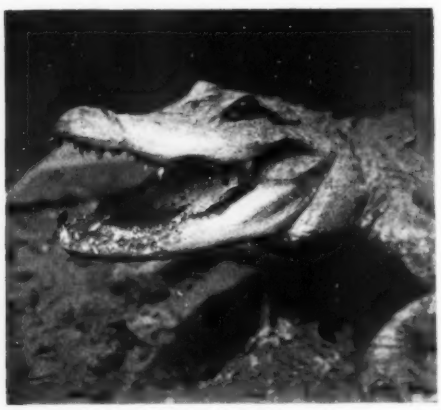
An alligator hole.—The retreat of the mother and several generations of young in time of danger

However, two baby alligators each a foot long, with their four little jewels glittering in the darkness, were too tempting to leave alone. As it is my habit to catch frogs with my left hand, I was carrying my heavy bag over my right shoulder. To free my left hand I held the bag of smaller frogs under my right arm during the moment of a catch. In this manner I approached the unwary infants, and as they were side by side, I snapped them up with one swoop of my left hand, thinking to myself—"Where is Mamma, to leave you all alone?" They answered merely with the "umph umph" characteristic of their kind. Immediately I heard a loud splash among the cypress ten yards away, and I think a louder "umph," but my memory is not entirely clear on this point,—for, upon swinging my head around, I saw two balls of fire, and the massive outline of a large black form darting at me with the speed of a locomotive and the fury of a tiger. A sickening fear seized me. Without knowing what I was doing, I threw the two children into the infuriated mother's face and started off on a wild race across the swamp, only an alligator nose in the lead.

I had not gone far when the race ended. It seems that some years before, just at that very point, a cypress knee happened to sprout. By the time I

reached that place in my wild race, it had not quite reached the surface of the water, but interfered with my progress to such an extent, that frogs and all, I fell flat on my chest in eighteen inches of water, extinguishing my light and thoroughly wetting my matches. Visions of conical teeth, crushing bones, and limbs twisted off at their joints scrambled through my mind.

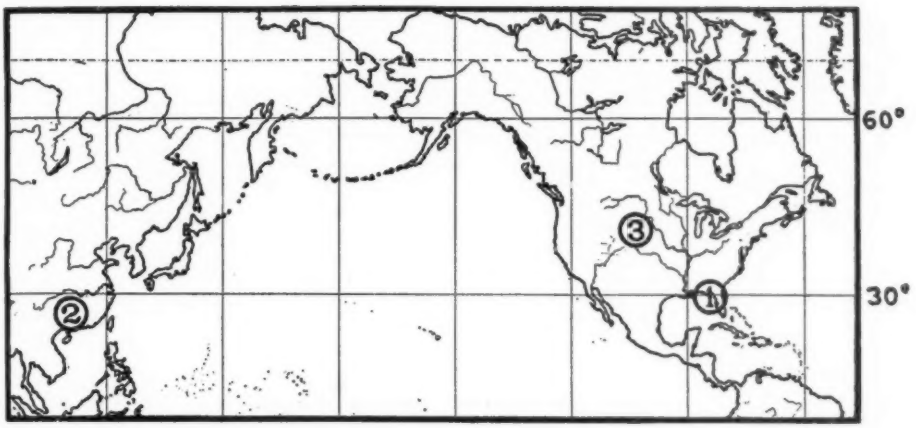
When I found my feet and recovered my sanity, all was silent but the plunk of *clamitans*, the grunt of *grylio*, the hoot of the barred owl, and "Leech" calling for help in the distance. The old alligator had again vanished into the night, and I had missed the opportunity of determining her size.



"Visions of conical teeth, crushing bones, and limbs twisted off at their joints." A close view of an old alligator

One feature of this experience which I could not explain was that I found myself still clinging tightly to the open ends of my bags. Not a frog was lost. It was uncomfortable to realize that my headlight and "Leech's" dry matches were separated by nearly a thousand feet of alligator heaven. As he had the lighter load and I was closer to the lake shore, I shouted to him to come. This he did eventually, after feeling his way inch by inch in the direction of my voice. It was fortunate that I did not communicate my experience to him for he probably would have climbed a tree and waited for daylight. At any rate, we are none the worse for our adventure of that night.

Many times since then I have turned over in my mind the behavior of this old reptile. Fear of man is usually the dominant instinct in an alligator. My experience with these creatures leads me to believe that "Old Fire Eyes" was hiding in her submerged subterranean tunnel and did not realize it was a human molesting her young, for she probably would have retreated upon this realization, even if her young had not been returned to her. Three generations of young alligators are usually found in or near the hole dug by the mother, and the catchers take advantage of this in securing them. Nevertheless, I have yet to hear of another such charge by an alligator. A still greater difficulty in accounting for my experience of that night is the fact that, while all crocodilians, so far as known, probably assist their young in hatching from the egg or at least in escaping from the nest, it is by no means certain that alligators pay any attention to their young after they make their way into the water. The evidence given above would lead one to believe that there may be a certain amount of parental care, but such evidence need not be interpreted in this way. My assumptions as to the sex and maternal instinct of "Old Fire Eyes" affords at least one explanation for the happenings of that night. It is hoped that these experiences will lead to further observations, before the possibility of true parental care in crocodilians, after hatching, is finally accepted or rejected.



The distribution of the alligators.—The fossil species (3) recently found in Nebraska is the direct ancestor of the Chinese form (2) and represents an interesting stage in the evolution of alligators from crocodiles. The alligator (1) living in America today has a very limited range

The Ancestry of the Alligators[1]

By CHARLES C. MOOK

Associate Curator of Palæontology, American Museum of Natural History

TWO species of the genus *Alligator* are living at the present time: one, the alligator of the southeastern portion of the United States, whose habitat is indicated by (1) on the accompanying map; the other, an inhabitant of eastern China (2). A fossil species of somewhat primitive character from the Oligocene beds has been described by Loomis.

During the summer of 1921 a fossil alligator skull was included in the collections made by Mr. Albert Thomson, in charge of the Museum's field expedition near Agate, Nebraska (3). The skull was collected from the Snake Creek beds of Middle Miocene age.

The detailed characters of the skull indicate clearly that it is a true alligator and not a crocodile, using the latter term in a restricted sense. When the skull is compared with that of a Florida alligator, decided differences are noticeable. The fossil skull is relatively broader and shorter, the lower jaw has a more wavy outline, and the teeth are much stouter. On the surface of the snout is a U-shaped structure, with the two arms of the U consisting of low ridges extending forward from the orbits. This character is not present in the Florida alligator but is present in the South American jacares.

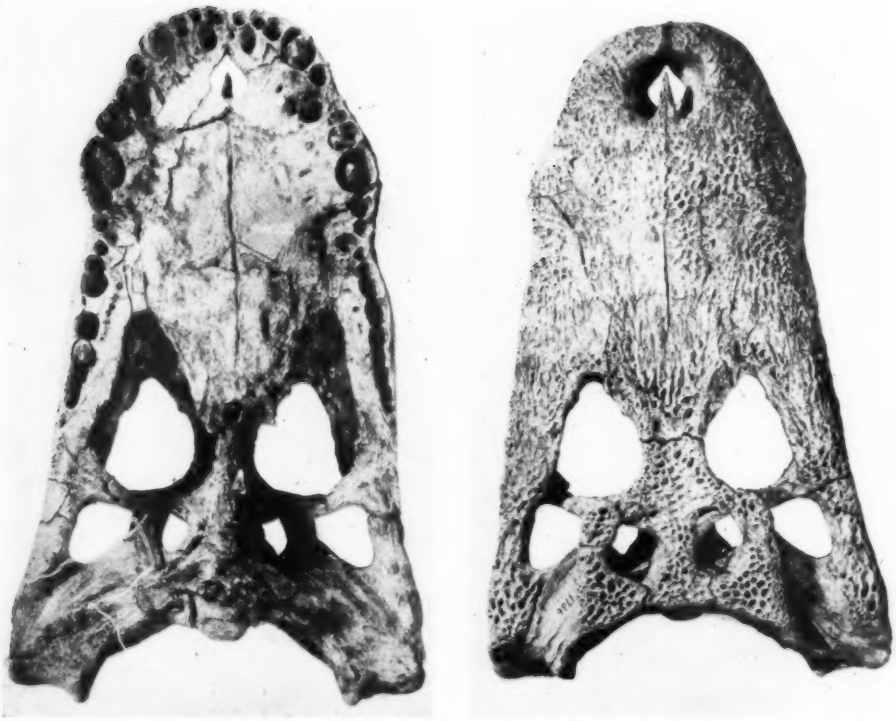
A comparison of the skull with that of a Chinese alligator (*Alligator sinense*) shows much less difference. The resemblance in fact is remarkably close. It is only by making careful studies of the details of the skulls and jaws that the fossil skull can be distinguished from the Chinese alligator. Small differences do exist, however, indicating that the fossil skull belongs to a new species. This species has been named by the writer *Alligator thomsoni* in honor of its discoverer.

This species may be considered as a direct ancestor of the living Chinese alligator. It is intermediate in structure between both of the living alliga-

[1](Contributions to the Osteology, Affinities and Distribution of the Crocodilia, No. 17).

tors and some of the early Eocene crocodiles of Wyoming.

The crocodiles with their narrow snouts and conspicuous front teeth are more primitive than the broad-snouted alligators. The steps by which the alligators were evolved from crocodiles is not fully represented by the fossil record. The discovery of this skull in the Snake Creek deposits adds one more link to our chain of evidence as to the ancestry of the alligator.



The skull of the fossil alligator from Nebraska, as viewed from below (left) and above (right).—The resemblance between this skull and that of the Chinese alligator is very close in spite of the great distance which separates the known ranges of the two forms. Alligators have evolved from crocodiles and differ from them most conspicuously in their broader snouts

On the Newly Discovered South African Man-Ape

By ROBERT BROOM

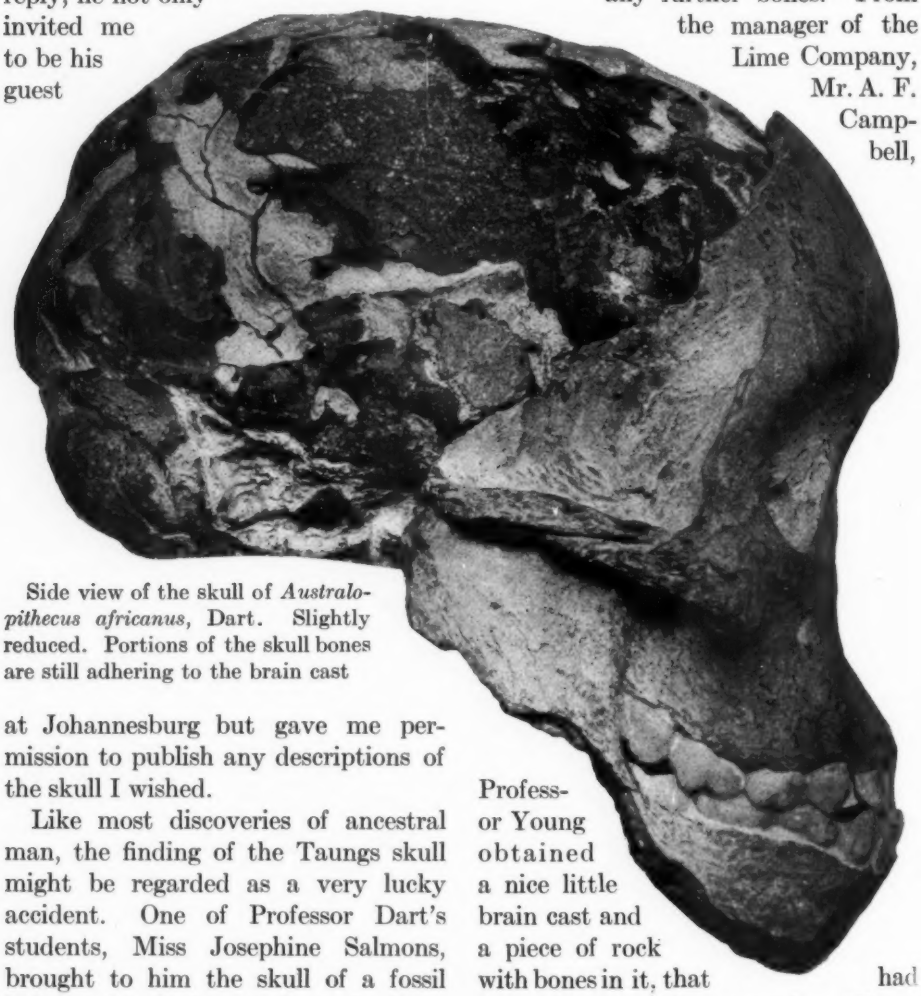
NOTE.—Readers of NATURAL HISTORY are fortunate in having a first-hand description of the famous *Australopithecus* skull by one of the ablest living palæontologists. Dr. Robert Broom, F.R.S., is well known to friends of the Museum from the valuable collections of South African fossil reptiles that he has secured for us, and from the brilliant series of papers, mostly technical,—yet suffused with his capacity to make technical studies clear and interesting—in which he published the results of his researches here upon the ancient fossil reptiles of Texas and South Africa.

The present description, for which we are indebted to Doctor Broom's long-standing friendship for the Museum, and also to the liberality and good will of Professor Dart, will be of particular interest, as it shows very clearly the comparative relations of the new find to "missing links" previously discovered. It also gives a detailed account of the teeth, which are perhaps the most reliable guide to the affinities of the animal. Third, and perhaps most important, Doctor Broom makes clear the real geological conditions of the find. The early accounts were very vague on this point, merely stating that it was found "in solid limestone fifty to seventy-five feet below the surface." Doctor Broom explains that it was really a cave or fissure specimen (as I had suspected from the first newspaper accounts) and probably not of any very great geological antiquity. There is no warrant, it seems, for referring to it as Pliocene; it is probably Pleistocene, perhaps quite late Pleistocene, but the geological age is not very exactly determinable. This has an important bearing on the problem of where man originated. Professor Elliot Smith regards this discovery as evidence that it was in Africa, and Doctor Broom apparently indorses this view. But the survival of a primitive "missing link" in South Africa to a comparatively recent date, long after such primitive and intermediate types had disappeared from central and northern Eurasia, might seem to be evidence not for but against Africa as the center where man originated. It accords with the "Rhodesian man," a survival of the Neanderthal species in Africa long after it disappeared from Europe, and with a good deal of other evidence along the same line. Whatever its age, and whatever its bearing on the place of man's origin, the new discovery is clearly one of the most important of the various intermediate types, no longer "missing links," that connect man with the higher apes.—W. D. MATTHEW

EARLY in February, 1925, the world was startled by the announcement of the discovery in South Africa of the skull of a young manlike ape, by Professor Raymond A. Dart of Johannesburg. A short account of the find appeared in *Nature*, where it was boldly stated that the skull was that of a man-ape, which in structure was intermediate between living anthropoids and man, that, unlike the living anthropoids, it had lived in the open plains, that it had walked more erect than the living forms and was thus more manlike; and in short that it was the long-sought "missing link." The daily press immediately took the matter up and gave the discovery wide publicity. Somewhat similar announcements have been made before, which, when investigated, resulted in disappointment, but Professor Dart had been for three years assistant to Professor Elliot Smith, the world-famous anthropologist, and is himself an eminent anatomist, so his announcement was accepted by all scientists as worthy of the most respectful consideration. Professor Dart will in due course give to the world a very detailed account of the discovery with sufficient illustrations, but this must take time and the matter is of such great importance that the world clamors for more facts.

Knowing how interested the Ameri-

can public is in the question of the origin of man, I at once wrote to Professor Dart asking him if I might examine the skull and write a short semi-popular paper on it for NATURAL HISTORY. In reply, he not only invited me to be his guest at Johannesburg but gave me permission to publish any descriptions of the skull I wished.



Side view of the skull of *Australopithecus africanus*, Dart. Slightly reduced. Portions of the skull bones are still adhering to the brain cast

Like most discoveries of ancestral man, the finding of the Taungs skull might be regarded as a very lucky accident. One of Professor Dart's students, Miss Josephine Salmons, brought to him the skull of a fossil baboon that had come from the limestone workings near Taungs. Similar heads have from time to time been discovered and a number are in the Capetown Museum, where they have been examined by Doctor S. H. Haughton, who has described them as *Papio capensis*. Doctor Dart thought that human remains might be found, as numerous human implements had been picked up already. Fortunately Professor R. B. Young, a colleague of Doctor Dart's, was going to a neighboring farm on a geological investigation, and Doctor Dart asked him to look out for any further bones. From the manager of the Lime Company, Mr. A. F. Campbell, Professor Young obtained a nice little brain cast and a piece of rock with bones in it, that had been blasted out just recently. These, when examined by Professor Dart, proved to be the brain cast of an anthropoid ape-like form, and the almost perfect face of the same individual imbedded in limestone. With amazing skill Professor Dart has removed the whole of the hard limestone from the face, palate, and teeth, and there remains the most interesting fossil ever discovered.

Before speaking of the fossil skull it may be well to say something of the geology of the spot where it was found.

On any good map of South Africa there will be seen, about forty miles west of Kimberley, the lower portion of the Vaal River, and north of it will be seen part of the Harts River and still farther north, the Dry Harts. These parts of the three rivers lie in one valley of great antiquity and very great interest. It was down this valley that the great Dwyka glaciers slid in Upper Carboniferous, or the Coal age—perhaps twenty million years ago. If the valley was not originally formed by the Dwyka glaciers, they certainly had much to do with its excavation.

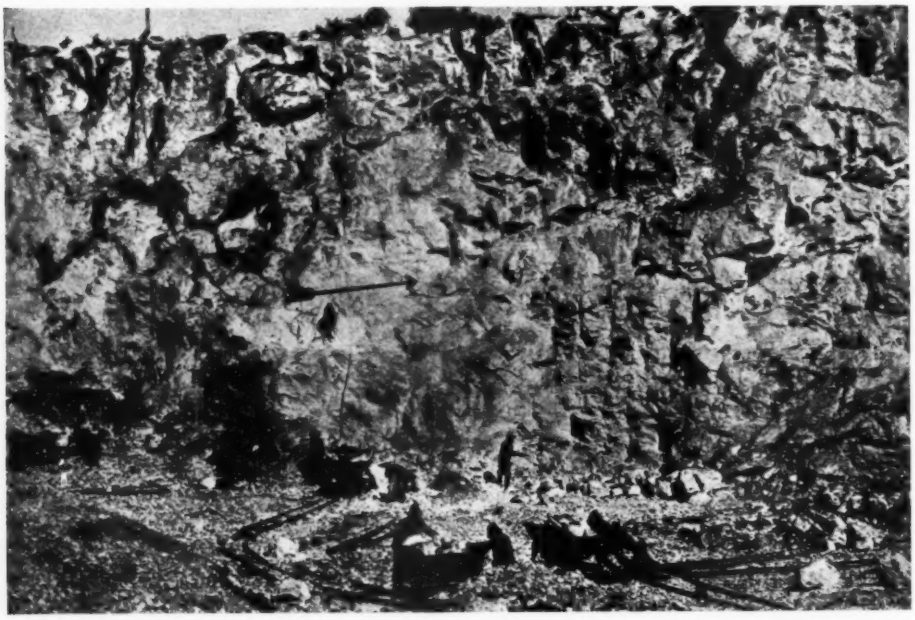
For some millions of years after the glaciers melted, a great Amazon-like river flowed down the valley, and the mud which it brought down and scattered over what is now the center of Cape Colony, formed the shales of the Karroo Beds, which are so rich in fossil reptiles. Gradually the valley itself became filled, in Jurassic times, with shales to a depth of perhaps two thousand feet. Then a change set in and the valley was reëxcavated and today it is in a condition not unlike that of Dwyka times. At Douglas and in many other places, we see exposed the ice-scratched rocks as they were left when the last glaciers melted. All along the west side of the valley ten or twenty miles from the rivers of today, there can be seen standing up like a huge black wall the escarpment or cut face of the high dead-level inner table-land, the Kaap plateau. This Kaap plateau is mainly formed of thick layers of magnesian or Dolomitic limestone. Rogers estimates the thickness at between two and three thousand feet, but in most places the escarpment is from a few hundred to about one thousand feet high. Along the black wall-like face are to be seen, every five or ten miles, light-colored patches, which examination proves to be great masses of calc-sinter or lime deposit, from lime-charged waters that have issued out of the Dolomitic rocks or flowed over their face. Some of these masses of secondary lime are as high as the whole escarpment and in some places some hundreds of feet deep. Occasionally, caves are formed in these large limestone masses.

At Buxton, near Taungs, there is a large mass of this secondary limestone, which has been quarried for some years. Already the mass has been quarried into for two hundred and fifty feet from the original face. The face at present being worked is seventy feet high. About fifty feet from the top there is a cut across an old cave, which has been filled up with sand, now largely cemented with lime. It is from this old cave that the man-ape skull comes.

As will readily be seen, it is quite impossible to give more than a rough guess at the age of the fossil. The masses of limestone must have been formed at a late date geologically, certainly in Tertiary or even more recent times,—probably more recent. They must have been formed when there was more rainfall than now; otherwise, the conditions probably did not differ greatly from the present. Certainly there could not have been a heavy rainfall with the existing forest conditions of that time. The only associated mammal bones described are of a baboon fairly closely allied to the living form. And I think we are safe in assuming that the cave and its contents belong to the Human period. But whether the man-ape lived one hundred thousand years ago or ten

thousand, the evidence at present does not show.

Professor Dart has named the little animal *Australopithecus africanus*. The face may be regarded as perfect, and the side view (p. 410) shows the brain cast attached to the face. It will be understood that the brain is not fossilized What happened is, that when the brain rotted away, the brain cavity gradually filled up with lime which in time hardened into a mass of solid limestone. When the specimen was blasted out, most of the brain-covering bones were shattered, but a nearly perfect cast of their inner surfaces has been preserved, and most of the sutures between the bones can be traced. We have only to allow a certain thickness for the bones destroyed and we can make a perfect restoration which leaves nothing to the imagination.



The quarry at Buxton near Taungs where the skull was found. The exact spot from which the skull came is indicated by the small arrow on the face above where the men are working

The skull is that of a young animal with milk teeth in a stage corresponding to that of a human child of six years. The side view shows a number of interesting features. If compared with young skulls of the gorilla, chimpanzee, orang, and Bushman, it will be seen that the resemblances are much more with the anthropoid apes than with man, and yet *Australopithecus* is more manlike than any of the known higher apes. The brain is relatively much larger and, as Professor Dart has pointed out, the poise of the head must also have been more manlike. He takes certain measurements, giving roughly the proportion of brain before and behind the supporting point of the vertebral column, which he calls the "head balancing index." The baboon provides a value of 41.3, an adult chimpanzee 50.7, Rhodesian man 83.7, a dolichocephalic (or long-headed) European 90.9, and a brachiocephalic

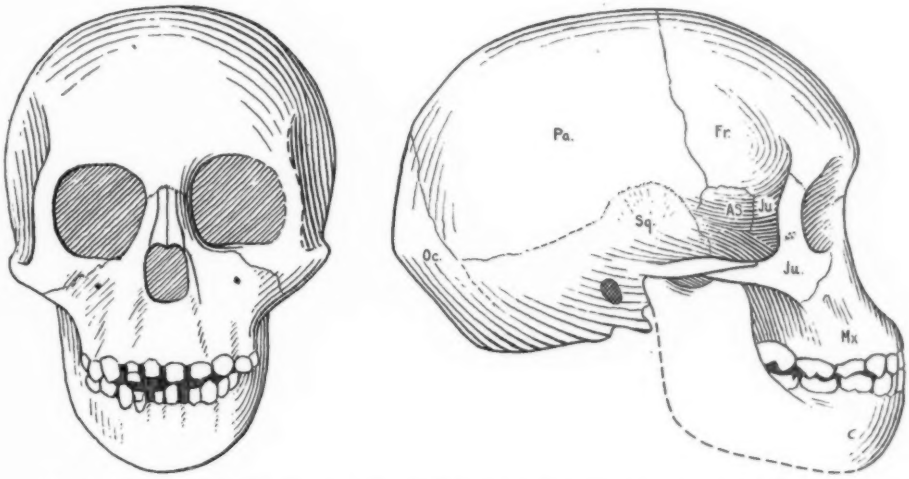
(or short-headed) European 105–8. In *Australopithecus* the index is 60.7. And he concludes that this new form had "an attitude appreciably more erect than that of modern anthropoids."

There are many points in the structure of the side of the head of interest to the anatomist, to which attention need not be called in a paper primarily intended for the general public. But it may be well to note that the arrangement of the bones in the temporal region agrees more with that of man than with that seen in the gorilla and the chimpanzee.

The side view of the skull shows the small flattened nose characteristic of the anthropoid apes and of the Bushman, and the close approach to the human mouth, with the small front teeth which meet each other, almost end on instead of at an angle, as in the anthropoids.

The front view of the skull shows other interesting human resemblances. There is the broad human-like nose with the nasal opening partly between the lower part of the eye sockets. This agrees with the condition in the gibbon and man, but differs from the condition in the gorilla and the orang. The young chimpanzee skull has a nose more closely approaching that of *Australopithecus*.

The teeth are of exceptional interest. There are preserved the practically perfect milk set, with the first upper and lower permanent molars.



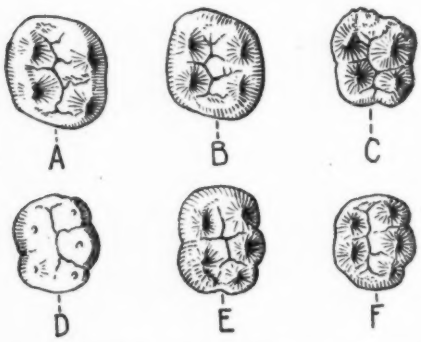
(Left) Front view of skull of *Australopithecus africanus* Dart. (Right) Side view of skull of *Australopithecus* Dart. As., Alisphenoid (Sphenoid); Fr., Frontal; Ju., Jugal (Malar); Oc., Occipital; Mx., Maxilla; Pa., Parietal; Sq., Squamosal (Temporal)

The incisors are small; in this respect they agree with man and differ from the higher apes. The upper milk canine or eye tooth is also small and not unlike that of the Bushman child. In all anthropoids the canine has a greater antero-posterior length than the first milk molar. In the Bushman child the antero-posterior length of the canine is to that of the first milk molar as 75 is to 90. In *Australopithecus* the canine has an antero-posterior length of less than three fourths that of the molar.

The milk molars agree much more closely with those of man than with those of any of the anthropoid apes.

The first true molar is preserved in perfect condition and is quite un-

worn. Though in the nearly closed condition of the jaws a full view cannot be had of the crown, it is possible from measurements of the cusps to give a drawing that can be fully relied upon. There are the four large cusps seen in all the anthropoids and in man. In man the molars vary greatly, owing to degeneration, but if a perfect undegenerate molar such as one finds in



Molar teeth of *Australopithecus africanus* Dart, with others for comparison. All natural size. A.—First upper right molar of orang. After Röse. B.—First upper right molar of *Australopithecus africanus*. C.—First upper right molar of Bushman child. D.—First lower right molar of chimpanzee. After Miller. E.—First lower right molar of *Australopithecus africanus*. F.—First lower right molar of Bushman child. The close agreement of the molars of *Australopithecus* with those of living anthropoids and man is striking; also the large size of the molars, showing that it was probably considerably larger than the chimpanzee

the Bushman child be compared with the molar in *Australopithecus*, the close agreement is striking, though the tooth of the latter is appreciably larger. The molars of the chimpanzee and the gorilla differ appreciably from that of the fossil form.

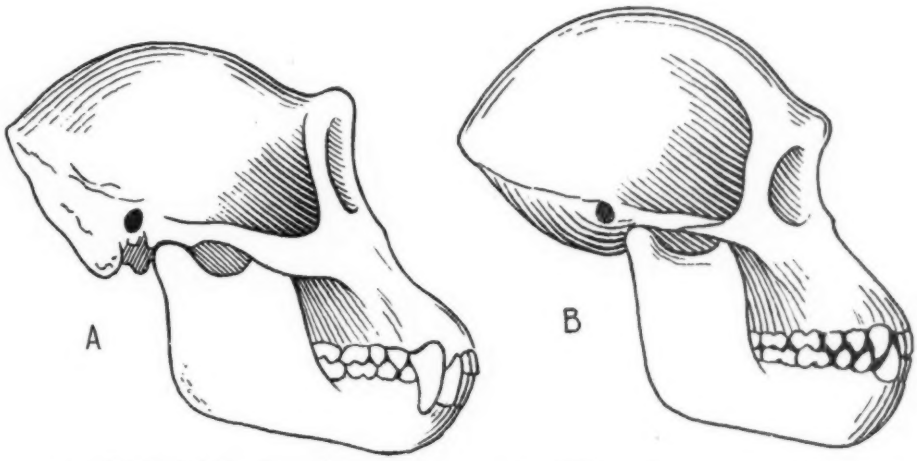
The lower incisors much more closely resemble those of man than those of the higher apes.

The canine is fairly large and pointed, resembling more closely that of the chimpanzee than that of man. But the milk molars, on the other hand, agree much more closely with those of man than with those of the chimpanzee.

The first true molar is well preserved and though a good view of the top of the crown cannot be had, the drawing I give is essentially correct in all details. In the anthropoid apes and in man there are two large cusps on the outer side and two large ones on the inner, generally with a fairly well-developed fifth cusp—the hypoconulid, as it is called—at the posterior and outer corner. In the gorilla and orang this fifth cusp is well developed on the second and third molars, but only very slightly developed on the first molar. In the gibbon and chimpanzee the fifth cusp is well developed in the first and second molars and only slightly developed in the third. In man it is generally present in a fairly well-developed condition in the first molar and usually very feebly developed, if at all present, in the second and third molars. But in some primitive races of men the fifth cusp is present in a fairly well-developed condition in all the lower molars. In *Australopithecus* the first molar is considerably larger than in man. On the outer side the three cusps are all well developed and subequal in size, and on the inner side the two are also well developed. The tooth thus makes a close approximation to the first molar of the chimpanzee, though considerably larger. It is also not unlike the first molar of man, though the fifth cusp is rarely, if ever, as large as in *Australopithecus*.

The study of the teeth renders it pretty certain that *Australopithecus* stands somewhere between the chimpanzee and man.

We know that the brain in the apes and in man grows comparatively little after the stage when the first molars appear



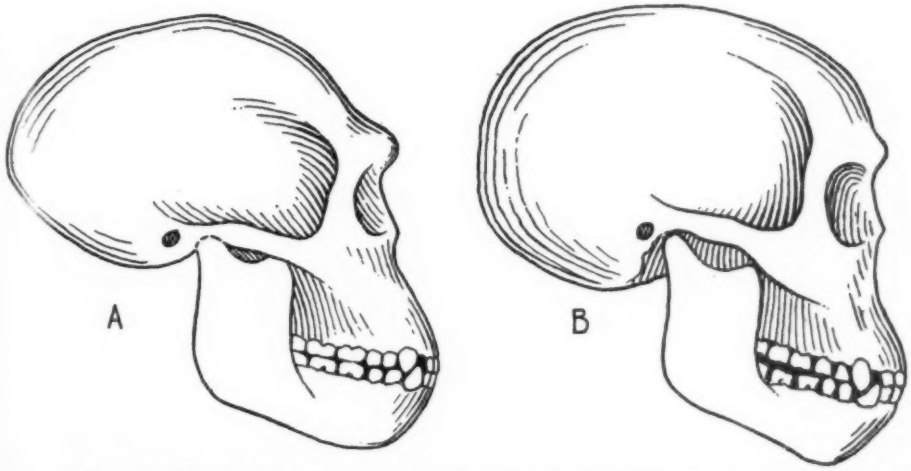
A.—Skull of chimpanzee, *Pan vellerosus*. After Elliot. B.—Attempted reconstruction of the adult skull of *Australopithecus africanus*

and that most of the changes are due to the great increase in the size of the jawbones to accommodate the large teeth and the greater development of the facial bones. It is thus possible to reconstruct the adult skull with almost perfect confidence when we know the brain in the half-grown animal and the size of the molar teeth.

When the adult skull is reconstructed, as in the figure I give, it is seen that we have a skull a little like that of the chimpanzee but with a relatively much larger brain and with smaller canine teeth. We know that there must have been enlarged canines from the presence of the well-marked gap between the canine and the second incisor, and the canine must have been smaller than in the chimpanzee, for a portion of the permanent canine can be seen in the fossil jaw.

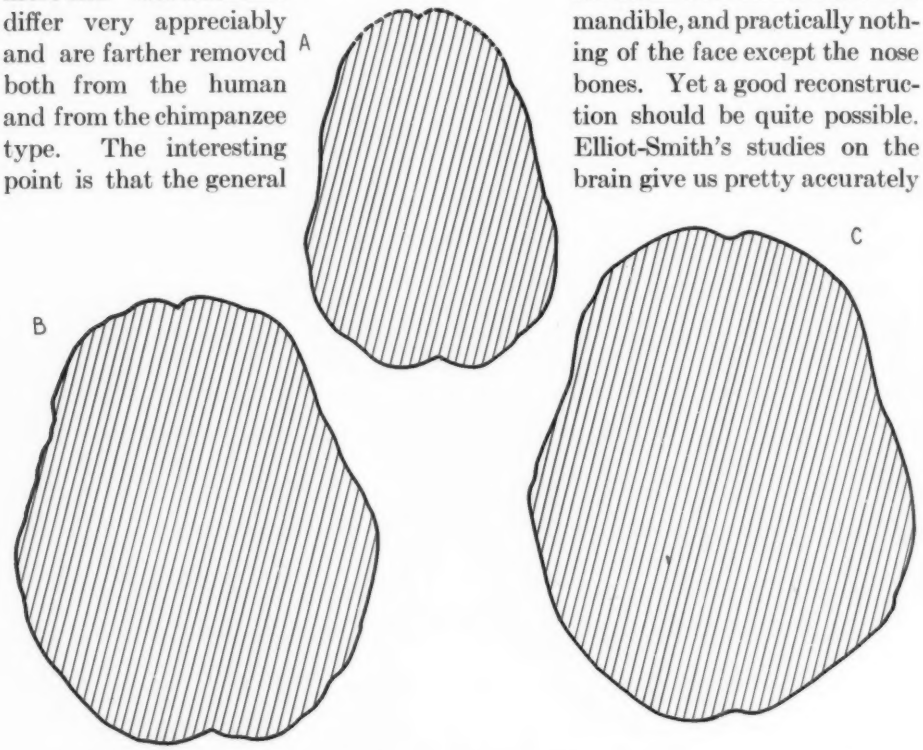
The likeness to the adult gorilla and orang is much less striking than to the adult chimpanzee.

The reconstruction I give at once



A.—Restoration of skull of *Pithecanthropus erectus*. After McGregor. B.—Restoration of skull of *Eoanthropus dawsoni*

calls to mind that made by Professor J. H. McGregor of the Java apeman, *Pithecanthropus erectus*. Unfortunately, of this type we know only the top of the skull and two teeth. The brain is very appreciably larger than in *Australopithecus* but rather more flat. The teeth also differ very appreciably and are farther removed both from the human and from the chimpanzee type. The interesting point is that the general resemblance is so striking as to suggest the possibility of a type like *Australopithecus* being the ancestor of a type like *Pithecanthropus*.



Brain outlines of (A) *Australopithecus* (juv), (B) *Pithecanthropus*, and (C) *Eoanthropus*. The last is from Professor McGregor's restoration

The next primitive human type with which a comparison must be made is the Piltdown skull, *Eoanthropus* of the south of England. Here we have a form with a moderately large human-like brain and a jaw which closely resembles in many ways the jaw of the chimpanzee.

Since *Eoanthropus* was discovered in 1913, various reconstructions have been made, the most important being those of Smith Woodward, Keith, McGregor, and Hunter, and the layman must feel a little worried that the reconstructions should differ so considerably. We have only, it is true, most of the brain case and much of the mandible, and practically nothing of the face except the nose bones. Yet a good reconstruction should be quite possible. Elliot-Smith's studies on the brain give us pretty accurately the structure of the brain case and we have thus only the face to reconstruct, and though the jaw is nearly perfect, it is surprising how different are the results that have been given us. As in South Africa, where I am writing, I have neither the bones nor casts, I must give a figure for this paper founded on one of those already published, and the one which seems to me the most satisfactory is Smith Woodward's. I have therefore taken Smith Woodward's restoration as a basis, but altered slightly his restor-

tion of the front of the jaw and greatly altered the restoration of the face to put it in keeping, as I believe, with the jaw.

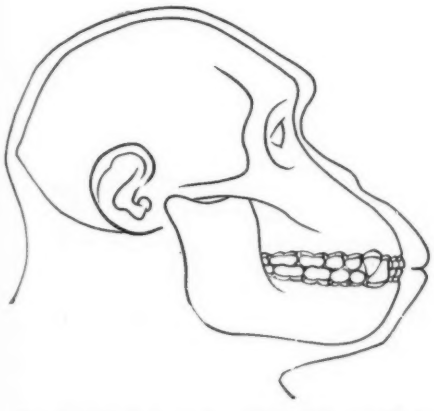
When the skull of *Eoanthropus* is compared with that of the adult *Australopithecus*, it will be seen that we have here a still farther step from the pre-chimpanzee to man. The brain has gone on enlarging and is now practically human. The face, however, is still ape-like. There is still the large canine of the ape but the molars are more human than ape-like.

All the other known pre-human or aberrant human types, such as the Neanderthal man, the Rhodesian man, the Heidelberg man, have a dentition that is not primitive, and though the skulls and brains show characters that differ considerably from the modern European type of *Homo sapiens*—large brow ridges like the gorilla, massive faces, and a less erect attitude—it is doubtful if these are really ancestral to ourselves. For many years I have regarded them as much modified side branches and I am pleased to see that Elliot Smith in his recent book *The Evolution of Man* also puts them in side branches.

It will be seen from what has been said that *Australopithecus* forms a most satisfactory connecting link between the anthropoid apes below and the various human and sub-human types above. And if the discovery results in the universal acceptance of the belief in man's evolution from the lower forms, the discovery of *Australopithecus* may have nearly as great an influence on human progress as the publication of Darwin's *Origin of Species*.

Photograph by A. M. Cronin

Pure Bushman, "Dial," one hundred years old, showing apelike face somewhat resembling the Piltdown man

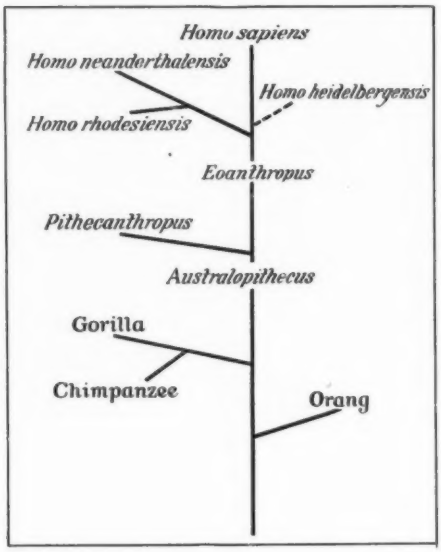


Head of adult *Australopithecus*.—This skull of adult *Australopithicus* is founded on the child brain with the jaw restored from the two first molars, which measure 14 mm. to 15 mm. The jaw must therefore be much as indicated and the whole skull cannot differ greatly from the restoration given

In the table on p. 418 an endeavor is made to show what may be the relationships of the higher apes and man and the connecting links and side branches, and the importance of *Australopithecus*, which may be regarded as the chief connecting link.

This table makes no attempt at giving the geological ages of the forms, and though *Australopithecus* may have

lived quite recently and thus could not have been the ancestor of *Pithecanthropus* or *Eoanthropus*, the endeavor is to show that these latter and the higher human types have all been descended from an *Australopithecus*-like type but not necessarily from *A. africanus*. *Australopithecus* may rather be regarded as a representative, probably of a group of large-brained anthropoids, from one of which the higher types have descended.



In connection with the discovery of the Taungs skull, Professor Elliot Smith regards the discovery as "the first definite confirmation of the opinion expressed by Darwin, which most people since his time have discredited—that Africa is the original home of the human family." The discovery no doubt confirms Darwin's opinion and we have herein another marvelous evidence of his insight. But it is interesting to note that nearly one hundred years before Darwin published *The Descent of Man*, the famous Scots evolutionist, Lord Monboddo, wrote in his great work *Origin and Progress of Language*, published in 1774, as quoted by W. L. H. Duckworth: "From the South Sea, I will come back again to Africa, a country of very great extent; in which, if it were well searched, I am persuaded that all the several types of human progression might be traced, and perhaps all the varieties of the species discovered." Lord Monboddo not only boldly maintained the descent of man from the apes but believed that the orang-utan was a degenerate human being. "That my facts and arguments," he writes, "are so convincing as to leave no doubt of the humanity of the Orang-utan, I will not take upon me to say: but this much I will venture to affirm, that I have said enough to make the philosopher consider it as problematical, and a subject deserving to be enquired into." Though this remarkable Scotsman failed to persuade his contemporaries, and his name would today be forgotten but for his association with Boswell, Johnson, and Burns, one feels it almost a patriotic duty to claim for him a place which is deservedly his as one of the pioneers of human evolution.

It seems to me not at all improbable that an adult *Australopithecus* will yet be obtained, and possibly a perfect skeleton. Should such a discovery be made, it would be difficult to overestimate its importance.

Louis Robert Sullivan
1892-1925

By CLARK WISSLER
Curator-in-Chief, Division of Anthropology, American Museum

DR. LOUIS ROBERT SULLIVAN, a young anthropologist of unusual promise and a member of the American Museum scientific staff, died in Tucson, Arizona, on April 23. He came to the Museum in 1916 as a student and assistant in the department of anthropology, and later was placed in charge of the anatomical collections. In 1920 the Museum was invited to join the Bernice P. Bishop Museum in Honolulu in an anthropological survey of the Polynesian Islands, and to Doctor Sullivan was given the racial problem. In the inauguration of this work he spent eighteen months in the Islands, where he made measurements and photographed a large portion of the native Hawaiian population. Some account of this work was given in the January-February, 1923, issue of this journal. Later, Doctor Sullivan prepared a memoir on "Marquesan Soma-

tology, with Comparative Notes on Samoa and Tonga," issued by the Bishop Museum. In this publication he made a general comparative study of the races in the Pacific, and formulated a working hypothesis as to the original elements entering into the mixture. At the time of his death he had well on the way to completion a second memoir on the Hawaiians.

Also, while in Honolulu, permission was given to him to examine the children in the public schools. In all, about 8000 persons were studied, and data collected as to their ancestry. Since a number of races attend these schools and intermarriages are frequent, these data were preliminary to a study of race mixture. Though Doctor Sullivan was not able to put this material in form for publication, the data will not be lost, but will serve as the basis for future studies in this field.

Doctor Sullivan returned to the Museum in 1921, but his failing health soon made it necessary for him to try a different climate. He took up temporary residence in Tucson, Arizona, and while there engaged in studies of the Mexicans and Indians attending the various schools. Later he made a general study of the Indian children in the Reservation schools of all the western states. He completed this work and tabulated the results in a form suitable for publication.

Doctor Sullivan was born at Houlton, Maine, in 1892. He was graduated from Bates College, Lewiston, Maine, in 1914. He taught biology in Tilton Seminary, 1914–15, then entered Brown University as a graduate student and as assistant in zoölogy under Professor H. E. Walter. From there he came to the American Museum. During the first years as a member of the Museum staff, he prepared himself for a career in anthropology by intensive studies in general biology, palæontology, and anatomy. The war broke in upon his scientific activities, for he felt the call to service, and was appointed First Lieutenant in the Section of Anthropology, Surgeon-General's Office, in 1918. While on duty at headquarters, he assisted in the compilation of the reports on Defects Found in Drafted Men and Army Anthropology. His special contribution was the determination of the 156 standard population sections, based upon the census returns of 1910, according to which the published studies of the Surgeon-General's Office were made. The section map and population table prepared by Doctor Sullivan in the course of this investigation give an adequate picture of the geographical distribution of the several national strains entering into the population of the United States. After the completion of this task Doctor Sullivan was assigned to Camp Grant, where he began an anthropometric survey of the recruits stationed there, but before the work was completed his quarters were destroyed by fire and his records lost. Then came the influenza, to which he fell a victim. This illness permanently impaired his health. Shortly afterward the war came to an end and he returned to the Museum. During the following winter he suffered a long and serious illness, and from that time on his vitality steadily weakened.

In all phases of his work at the Museum and elsewhere, Doctor Sullivan showed conspicuous ability and fine judgment. When recommending his appointment to the Museum staff in 1916, Professor H. E. Walter of Brown University, his teacher in biology, wrote, "He is a quiet fellow sane, clear-eyed, persistent, not afraid

of work, with a scholarly mind and a lot of native ability. He makes good with monotonous certainty in every proposition he takes up. I am sure that he will make good somewhere." That these words were prophetic everyone acquainted with Doctor Sullivan will agree. His untimely death is not only a great loss to the Museum but to anthropology in general.

Though granted but a few years of mature professional life, his bibliography covers twenty-five titles reporting upon original work, and ten important reviews of publications in his field. His major contributions are noted below:

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NOTES

ASTRONOMY

ASTRONOMICAL EXHIBIT.—On exhibition in the astronomical and memorial halls of the American Museum, May 13 – June 15, were paintings, photographs, and drawings of the solar eclipse of January 24, 1925, as well as those of 1900, 1901, 1905, 1918, and 1923. Among these were paintings by Mr. Howard Russell Butler, of the eclipses of 1918, 1923, and 1925, and of the Northern Lights which were observed in August of the year 1919. There were also paintings of the eclipse of 1925 by Mr. Aleth Bjorn, Professor Baker, and Professor Fuertes, of Cornell University. A lecture on "The Recent Total Eclipse of the Sun" was delivered on the opening night by Professor John A. Miller, director of Sproul Observatory, Swarthmore College.

The photographic transparencies recently installed in permanent exhibition cases in the astronomical hall, picturing Halley's comet, meteorite showers, astronomical instruments, observatories, etc., attracted the attention of many Museum visitors.

The exhibit was made possible through the courtesy of the United States Naval Observatory, Fuertes Observatory of Cornell University, Vassar College Observatory, Yale University Observatory, Sproul Observatory of Swarthmore College, Van Vleck Observatory of Wesleyan University, Yerkes Observatory of the University of Chicago, Mt. Wilson Observatory, Maria Mitchell Observatory, Lowell Observatory, Lick Observatory, the Smithsonian Institution, the New York Edison Company, and amateur astronomers.

The Museum architects, Messrs. Trowbridge and Livingston, are collaborating with Mr. Howard Russell Butler of Princeton, New Jersey, in the preparation of plans for the proposed astronomical hall which is to occupy the place of the present auditorium. This hall will include five floors, and will cost $2,000,000. The first floor will be devoted to the Museum's large collection of meteorites. On the second floor will be a great hall, extending through the third floor, for astronomical models and exhibits, while the astronomical hall proper will extend from the fourth floor through the fifth and sixth floors and will be capped with a huge dome, which will represent the heavens with the constellations.

On August 20, Dr. G. Clyde Fisher leaves New York to visit Jena, Berlin, Munich, Vienna, Zurich, Paris, and London, for the purpose of observing astronomical apparatus in these cities.

COMPARATIVE ANATOMY

THE UNIVERSITY OF TASMANIA RECEIVES MAMMAL COLLECTION.—A note recently received from the Registrar of the University of Tasmania states that the valuable collection

of mammals recently sent to the Biology Department of the University from the American Museum has arrived there safely. This is one of a series of exchanges which the American Museum has arranged with the museums in Australia, Tasmania, and Polynesia.

EXTINCT ANIMALS

THE STRUCTURE OF THE DINOSAUR EGG SHELL.—Some pieces of the famous dinosaur eggs secured by the Third Asiatic Expedition have been sent by Professor Henry Fairfield Osborn to Professor Victor Van Straelen of the Université Libre, Brussels, Belgium, for micro study. Professor Van Straelen has just published a short preliminary statement of his finding in *Novitates* (No. 173). He concludes: "Thus there are striking differences between the eggs of Shabarakh Usu and those of Iren Dabasu. The first-named cannot be correlated with any of the actually known eggs, either living or fossil. The second-named have a structure similar to that of the supposed eggs of *Hypselosaurus priscus*, the dinosaurian of Rognac, which themselves have a structure that partakes of the characters of both the palæognathic and neognathic birds. But the Iren Dabasu eggs differ essentially from the Rognac eggs in the shape of the aëriferous canals."

The fossil eggs secured by the Third Asiatic Expedition were believed to be those of dinosaurs because of their association with the remains of certain dinosaurian fossils. They exhibit a general resemblance in form to the eggs of crocodilians, which is, perhaps, only natural, for crocodiles and dinosaurs have sprung from the same stock of reptiles. Some of the eggs possess fragments of the embryo skeleton within them but these parts have not been fully studied as yet. It is therefore of great interest to see exactly what light the microstructure of the egg shell throws upon the identification of the eggs as dinosaurian.

The eggs of turtles, crocodiles, and birds resemble each other superficially but differ in their form and microstructure. The dinosaur eggs secured by the Third Asiatic Expedition agree with crocodile eggs not only in form but also in the great variability of surface texture. They differ strikingly, however, from crocodile eggs in the great thickness of the middle or so-called "prismatic layer." A second difference lies in the form and arrangement of the fine tubules which perforate the entire shell permitting the young dinosaur to respire before hatching. In the crocodile there are two kinds of tubules of different sizes, the larger being visible to the unaided eye. In the dinosaur eggs there is only one kind of tubule of very small diameter. This tubule has a different form in the eggs collected at Iren Dabasu than those from Shabaraku Usu. Thus, Professor Van Straelen was able to confirm the observations of Professor Osborn that at least two types of eggs were represented in the collection.

The dinosaur egg shells differ from those of birds not only in form but also in thickness. In the primitive ostrich-like birds, (except *Apteryx*) the respiratory tubules ramify in the prismatic layer terminating on the surface in a group of pores lining a single depression. In the dinosaur eggs the tubules do not ramify, but are straight as in the case of the higher birds.

In detailed structure, the dinosaur egg shell differs from those of crocodiles, birds, or turtles, and agrees only with an egg shell of uncertain origin found in the upper Cretaceous of Rognac, France. In the light of the discoveries of the Third Asiatic Expedition, it is now highly probable that all these eggs are dinosaurian.

FISHES

The editors of the *National Geographic Magazine* interpret the function of their journal in so broad and liberal a spirit that they win the hearty commendation of all nature lovers, for they include in its columns from time to time articles on various natural history subjects. Furthermore, they add to their good deeds by collecting such articles and issuing them as books. For instance, one recently appeared, embracing certain articles by E. W. Nelson entitled, *Wild Animals of North America*, and illustrated with many photographs and wonderful color plates by Louis Agassiz Fuertes.

For some years past the souls of ichthyologists have been rejoiced by the publication in the *Geographic* of excellent and beautifully illustrated articles on the fishes and fisheries of North America. These articles have now been issued in book form under the editorship of John Oliver La Gorce, and bear the title *The Book of Fishes: Game Fishes, Food Fishes, Shellfish and Curious Citizens of American Ocean Shores and Rivers.*

In this handsome royal octavo volume of 243 pages are brought together articles in the *Geographic* from the pens of J. O. La Gorce,

C. H. Townsend, L. L. Mowbray, J. T. Nichols, H. M. Smith, and F. W. Wallace. These articles are not merely interesting but are valuable because authoritative. Not the least striking part of the book are the 134 illustrations from photographs and the 92 color plates of familiar salt- and fresh-water fishes *made from life* by that skilful artist, Hashime Murayama. The value of these color plates cannot be overestimated. The department of fishes in the American Museum is frequently asked "Where can I get an accurate figure—colored if possible—of the (here naming some certain fish)?" The answer is before us for 92 kinds. In publishing these articles, and especially in having had made and in issuing the color plates, the *Geographic* and its editors have done the science of ichthyology no small service.

INSECTS

FIELD STATION FOR THE STUDY OF INSECTS.—Last winter visitors to the American Museum were attracted by an unusual exhibit,—a case containing not mounted specimens but live insects engaged in preying upon other insects, chewing tobacco (for some insects, like men, are fond of the weed), egg-laying, crawling, flying, jumping, or oaring their way over the smooth surface of a bowl of water. Only a few, however, of a vast number of interesting forms of insect life could thus be shown and the setting was necessarily artificial. Today, thanks to the coöperation and courtesy of the Commissioners of the Palisades Interstate Park and the generosity of Mr. William Averell Harriman, the Museum has had placed at its disposal a forty-acre tract near Tuxedo, New York, where a field station for the observation and study of insects is being established under the direction of Dr. Frank E. Lutz.

Although facilities for research students are contemplated, it is the great interested lay public that will be the immediate beneficiary. The tract will be virtually an insect zoo. Instead of walking from cage to cage in an enclosed building, the visitor will follow a path through the open, leading past this group of insects and that, each properly labeled so that an insight may be had into the life history of these little creatures which in spite of their diminutive size play a rôle in the affairs of the globe that rivals that of man, and upon whose conflicting or complementary interests the fate of man is in no small measure dependent.

A brook traverses the tract, and some of the aquatic insects that live on its surface and below will be shown in glass bowls. Thus the station will combine the attractions of an aquarium with those of a zoo.

An interesting educational feature of the station will be the unlabeled exhibits, paradoxical as this may at first seem. After the visitor has followed the route by a number of described exhibits and has imbibed the knowledge that is spread out for his eye to read, the opportunity will be given, should he so elect, to demonstrate what he has learned by following a route in which similar but unplacarded exhibits appear, and these, as a test, he will be asked to name and describe.

Young assistants, working under Doctor Lutz, will replenish the exhibits as new live specimens are required and will assist also in making the sojourn of visitors as profitable and enjoyable as possible.

The tract is located at the intersection of the proposed Bear Mountain-Greenwood Lake and the Tuxedo-Southfield highways, just at the point where one leaves the latter road when going through the Park to Bear Mountain, and it is hoped that all who read this Note will avail themselves of the opportunity of visiting what is in several respects a unique undertaking.

PREHISTORY OF MAN

THE WORD PITHECUS.—We may quote from an interesting note in *Nature*, June 6, 1925, page 875, by Raymond A. Dart, on the proper use of the Greco-Latin word *pithecus:*

"It has been stated by several critics that the word 'Australopithecus' is a hybrid (Latin-Greek) term. I am indebted to my colleague Mr. T. J. Haarhoff, professor of classics in the University of the Witwatersrand, for the information that *pithecus* was a recognized naturalised Latin word in Rome. It was used by Cicero's own secretary, Tiro, and by other accredited writers, and more than a century before Cicero's time Plautus employed the diminutive *pithecium*. It is, therefore, not surprising that both of these words are to be found in a standard Latin dictionary, such as that of Lewis and Short. The still commoner *cercopithecus* is found in Pliny, Varro, Juvenal and Martial, to the last-named of whom (Book XIV, Epigram 202) we owe one of the most pleasing examples

of the indiscriminate juxtaposition of the two words used by polished Romans for a monkey:

> Callidus emissas eludere simius hastas
> Si mihi cauda foret cercopithecus eram.
> 'A monkey, cunning to avoid darts, hurled at me
> (the charge that)
> I should be a tailed ape, had I a tail.'"

Naturally, *pithecus* has been the classic term availed of over and over again by zoölogists to designate fossil or recent members of the Primates. Among the anthropoid apes, for example, the chimpanzee and the gorilla were long deemed so closely allied and so imitative of man that they were placed in the single genus *Anthropopithecus*. When some generalized Pliocene apes were found in France and in Asia, they received the jungle name *Dryopithecus*, signifying "Ape of the Forest." Recently, Raymond A. Dart proposed the named *Australopithecus*, or "Ape of the Southern Hemisphere," for the newly discovered Taungs skull. Gregory suggested to the writer the well-chosen term *Hesperopithecus* signifying "Ape of the Western World," for the already famous Nebraska tooth.—H. F. O.

Lost Foxhall Jawbone.—Our readers will recall Professor Osborn's article on Pliocene man in Great Britain in Natural History Nov.-Dec., 1921, in which was described "The Pliocene Man of Foxhall in East Anglia," the human jawbone said to have been found in the Foxhall beds with these great upper Pliocene implements. This jawbone was described and figured by Dr. Robert Collyer, with whom it seems to have disappeared; vigorous search has since been made for the life history of Dr. Collyer in the hope of locating the fossil jawbone. In the April *Scientific American* there was published a notice in this connection, of which Mr. Moir in his letter of May 3 says: "I am glad to see that the Foxhall jawbone was again mentioned in a recent number of 'The Scientific American.' I thought Hrdlicka's criticism following my paper in the American Journal of Physical Anthropology rather in the nature of begging the question." In response to the article in the *Scientific American* two letters have been received, from which we quote:

"A Dr. Robert Collyer (an uncle of mine), was an Englishman and moved to Philadelphia from London, England. I think he spent most of his life in England. He died in New Orleans about twenty years ago, at the English Colony's Home, aged about ninety years. I think he is the doctor you are trying to locate."

"In Dickson and Montgomery Counties in Tennessee some thirty years ago I met the descendants of 'the Collyers,' and Van Leers, who came from England or Scotland about 1800. . . They made sugar kettles for the planters of Louisiana. General (afterward President) Jackson knew them; they made cannon balls for him with which he fought the British at New Orleans in 1812. . . The Collyers still probably live at Charlotte. . . . I've heard some people speak of a Doctor Collyer about the Civil War times, 1861 to 1865, and about his interest in 'the fossils' that I understood they found in the iron ore beds in the surrounding country."—H.F.O.

Beginnings of Intelligence.—In an article in the February *Forum* Professor Osborn observes that it is not man's physical structure which makes him human, but his moral, intellectual, and spiritual nature alone: "Regarding intellectual evolution, the case immediately becomes more difficult. I was never so impressed with this fact as in my journeys among the former habitations of the cave men in northern Italy, France, and Spain. I soon conceived a great admiration for these men because of their undoubted intellectual powers as observed not only in the superb development of the brain, but also in the high observational and artistic powers manifested in their art. I am perhaps more proud of having helped to redeem the character of the cave men than of any other single achievement of mine in the field of anthropology. The cave man bore, and still bears, an evil reputation of being a brute."

On this article a correspondent, Mr. A. H. Chisholm of Sydney, Australia, comments:

"Certain of your observations regarding the brain power of primitive races agree largely with certain instances that forced themselves recently under the notice of the ornithologists of New South Wales, of whom I am chairman. There came to us one David Unaipon, a full-blooded aborigine, who had been taken young and educated, and who pleads the cause of his vanishing people at every opportunity. The man himself is his best argument. He speaks most fluently, yet never rants and never needlessly weeps. Some of his points as to the psychology of aborigines and animals were arresting. (Dr. Basedow has something to say on the same point in his just-published book.) To back Unaipon there was Douglas Grant. Douglas is a full-blooded aborigine

from North Queensland (Unaipon comes from South Australia) where he was rescued during a massacre by one of our ornithologists, Robert Grant. Mrs. Grant cared for the little two-year-old black, checked his eating raw meat, and eventually brought him to Sydney. He grew to be a fine lad (with an amusingly Scotch accent acquired from his foster-father), went through the Great War well, and is now back as a draughtsman in a small arms factory. No mean performance, I suggest, for a member of probably the most 'primitive' race now living." H. F. O.

MEN OF THE OLD STONE AGE.—The well-known book by Professor Henry Fairfield Osborn, of which three editions have been published in America, has recently appeared in Russian. The translator, Dr. B. N. Wishniewsky, anthropologist of the Russian Academy of Sciences, says in his preface that this book is "the best popular statement of the theme." The original text is supplemented by two articles by the translator. One of them, "Ancient Man in the Light of Latest Studies," gives a review of the latest contributions to the subject up to 1923, most widely known in America and Western Europe. Another article, "Prehistoric Man in Russia (The Stone Age)" is based mainly on the literature published in Russian, and consequently a review of this will be interesting to American readers.

Man seems to have appeared on Russian territory comparatively late. The most ancient, somewhat doubtful, findings of the stone implements on the Kuban River, southeastern Russia, show implements of Mousterian type belonging presumably to the last or fourth glaciation (Würm stage). Better known, and rather plentiful, are findings of a somewhat later date referred to the end of the fourth glaciation. All belong to the southern half of Russia, the most northern lying about 55° N. latitude, and are scattered in the basin of the Dnieper River, at the sources of Prut and Bug, on the Oka River, Don, and in central Transcaucasia. In Siberia, vestiges of the Old Stone Age have been found near Tomsk, near Krasnoyarsk, on the upper course of the Yenisei River, and near Irkutsk.

Owing to the prevailing character of the country, most of the findings represent camps, and cave dwellings are rare. Very interesting is the camp near Kostenki on the middle course of the Don River. It shows three layers with the implements of the Solutrian and Magdalenian types. Here has been found a beautiful statuette, made of mammoth's tusk. Unfortunately, the head is missing. The statuette represents a pregnant woman, without stylized exaggeration of the sex characters which is usual in the figures found in western Europe, and showing no steatopygia, or accumulation of fat generally. Absence of these features in the statuette may express a racial characteristic of the people who occupied this Kostenki region. The camp found on the territory of Kiev (so-called Kirilovski) had been occupied three times at least, and part of the implements belong to the Aurignacian type. Remains of mammoth, woolly rhinoceros, cave bear, lion and hyena, partly fire-burnt, have been found, and also wood of nut pine and spruce which now are found much farther north. A camp near Mesino, province of Chernigov, about 150 miles farther north, belongs to the Magdalenian epoch. Here, remains of the mammoth, horse, and also of northern mammals, such as arctic fox, musk ox, and reindeer have been found. Discoveries of cultural interest in this camp are pierced shells of Tertiary mollusks, used as adornments, while the implements are represented by a big store of reindeer antlers, mammoth tusks, and flints. The only cave deposit of this age in Russia has been found quite lately in Crimea near Simferopol. This may have been only a temporary refuge and not a regular dwelling. Of the implements all that is known is that they belong to the Old Stone Age. The accompanying fauna shows a form of the mammoth, woolly rhinoceros, cave hyena, the saiga antelope, and two species of horses, one of which is middle-sized, and the other about the size of a small pony. Quite recently, a discovery of human remains has been reported which, according to the newspapers—perhaps too sanguine—belong to the Heidelberg race.

Near Tomsk, western Siberia, vestiges of a meal around the carcass of a young mammoth have been discovered—burnt and split bones, ashes, and plenty of stone splints which served as table knives. The time is described as late Palæolithic.

The findings near Krasnoyarsk are referred to the Aurignacian culture. Noteworthy among the animals that were hunted by prehistoric man is the argali, or giant mountain sheep, which now lives no nearer than 400 miles south. It is extremely interesting to learn that ancient inhabitants of Siberia seem

to have been much less endowed artistically than their western European and Russian contemporaries. No objects of adornment at all, nor scarcely any ornamentation of the implements have been discovered thus far in Siberia, among the remains of this age.

Much more plentiful, and better known, are the vestiges of the New Stone Age, from Crimea up to the White Sea, and in many places in Siberia. Well known are the remains referred to the late date of 3000–2000 B.C., found near Hadago Lake, with two races of domestic dogs, and with a dolichocephalic, or long-headed, human race which may have been the ancestral stock of the Velikoross, or Great Russian, tribe. Of cultural interest should be mentioned excavations near Tripolie, province of Kiev, containing ornamented pottery of the type spread from the Balkan Peninsula to Transcaspia (Anau) and Afghanistan; and excavations near Bologoïe, halfway between Moscow and Petrograd, where the use of pigments and indications of cannibalism have been discovered.

Unfortunately, little is known about the anthropology of the Old Stone Age in Russia. In Piatigorsk, North Caucasus, remnants referred to the Neanderthal race have been found. Their geological age is conjectured as fourth glaciation but they have not been studied *in situ* by an expert. This has also been said of the alleged discovery of a very ancient race in Crimea. Deposits of later Old Stone Age cultures for Russia are practically unknown; only near Krasnoyarsk, scanty remnants, not yet determined, have been discovered.—PETER P. SUSHKIN.

REPTILES AND AMPHIBIANS

DR. G. KINGSLEY NOBLE, curator of the department of reptiles and amphibians in the American Museum, will sail for Europe on August 5 to visit the various foreign museums with a view to arranging a series of important exchanges. While in England, he will address the Zoölogical Society of London, and the British Association for the Advancement of Science.

Among the researches just published by the department there are several of general interest. In two of the recent numbers of *Novitates* Doctor Noble has attempted to trace out a phylogeny of life history within the Amphibia. It is only during the past few years that a natural classification of the Amphibia has been established. Doctor Noble was able to show that there is a close correlation between the mode of life history and the phylogenetic relationships of a genus.

In a paper recently published in the *American Naturalist*, Doctor Noble has considered "The Evolution and Dispersal of the Frogs." This represents a defense of the thesis advocated by Dr. W. D. Matthew in his paper "Climate and Evolution" that the Amphibia arose in the north and spread southward to occupy their present ranges.

One of the most curious specializations found among the Amphibia is a growth of hairlike structures found on the sides of the thighs and body of the "hairy frog" of Africa. These structures have been studied microscopically by a number of investigators, but no satisfactory explanation of their significance was hitherto obtained. In the current number of the *Journal of Morphology and Physiology* Doctor Noble has showed that these are supplied with an extraordinary blood supply and apparently function as accessory breathing organs. The development of the villosities is correlated with the reduction of the lungs. The paper includes an investigation of the vascularization of the integument of a large series of Amphibia. The changes which take place in the skin and heart of all Amphibia when the lungs are reduced are described. The paper is entitled: "The Integumentary, Pulmonary, and Cardiac Modifications Correlated with Increased Cutaneous Respiration in the Amphibia; a Solution of the 'Hairy Frog' Problem."

THIRD ASIATIC EXPEDITION

MR. CLIFFORD H. POPE assistant zoölogist of the Third Asiatic Expedition, is continuing his brilliant researches on the life histories of Chinese Amphibia. He has proceeded to Yenping, in the province of Fukien, and writes from the field under date of April 25:

"After exactly three months of more or less steady traveling, I reached this city April 11. At Shanghai the joys of travel were left behind and I went from bad to worse until at last I came up here from Foochow packed like a sardine in a tiny launch with forty Chinamen and two Russians.

I arrived in the field too early in the season and found the weather very cold and rainy. Although we have been here two weeks it is still raining. Specimens are just coming out. I plan to work here a month and then to go

up to the northwest border of the province and try my luck there for another month, leaving two men here to purchase specimens which may be brought in by the collectors. In the late summer I hope to work near the coast for a month.

The mountains near Yenping are about as high and wild as any in the province and the safest to work,—in other words most free from bandits. We are living in a temple ten minutes from the city and among wild, steep mountains. Here we can secure specimens from all altitudes from three hundred to four thousand feet. The temple is about a thousand feet above sea level. I have quite a crowd of Chinese at work. Yesterday I went up into the highest mountains and there in a small cold stream found *Pachytriton* abundant but saw no sign of eggs. In high streams we found a frog which appears to be La Touche's *Leptobrachium boëttgeri* and also *Microhyla* tadpoles with the strange mouth parts.

I have not tried the flash-light work so far, but hope to begin before long. It is no small matter to keep the three local collectors and the three Peking men all at work. Today I have visitors,—two small boys from the Yenping mission. That makes ten here in the temple. They have come to stay over the week end.

One of the local collectors in our group is a famous tiger hunter who has shot seventeen tigers and several dozen leopards. He is a fairly good general collector and a thoroughly responsible fellow.

The only misfortune so far this trip was the result of a poorly placed load of dynamite. Twenty-five feet of mountain scenery are no more! The load did not sink straight."

NEW MEMBERS

At recent meetings of the Executive Committee of the American Museum of Natural History, the following resolutions were unanimously adopted:

Resolved, That the Trustees desire to express to Professor Eugene Dubois their deep appreciation of his gift to the Museum of the first casts of the original specimens of *Pithecanthropus erectus*, which makes such a precious and important addition to the Museum's series illustrating the evolution of man, and in recognition of his gift and of the great importance of his scientific discoveries take pleasure in hereby electing Professor Dubois an *Honorary Fellow* of the American Museum of Natural History—the highest scientific honor in the power of the Trustees to bestow.

Resolved, That the Trustees desire to express their appreciation of the achievements of Mr. Francisco Ballén and Mr. J. A. de Lavalle y García in preserving and in developing the Guano Islands of Peru and in building up the greatest industry ever based upon animal conservation. In recognition of their contribution to science and to the cause of conservation, the Trustees take pleasure in hereby electing them *Honorary Life Members* of the American Museum of Natural History.

Resolved, That the Trustees desire to record their appreciation of the faithful and sympathetic manner in which Doctor Dana W. Atchley is safeguarding the health and well-being of our employees, and in recognition of his services to the Museum take pleasure in electing him an *Honorary Life Member*.

Since the last issue of Natural History the following persons have been elected members of the American Museum, making the total membership 8273.

Patrons: Mrs. William Boyce Thompson; Mr. Guerdon S. Holden.

Honorary Fellow: Prof. Dr. Eug. Dubois.

Honorary Life Members: Dr. Dana W. Atchley; Messrs. Francisco Ballén, and José Antonio de Lavalle y García.

Life Members: Mesdames A. Wentworth Erickson and Winifred MacCurdy; Messrs. Wm. J. Boardman, George W. Chauncey, Oscar Daniels, Jesse L. Eddy, W. C. Gotshall, Van Campen Heilner, and William J. Rucker.

Sustaining Members: Mesdames Bruce-Brown and Marius de Brabant; Messrs. Seneca D. Eldredge, R. C. Leffingwell and Edward Townsend.

Annual Members: Mesdames B. E. Allyn, Courtlandt D. Barnes, Jean H. Caldwell, Robert J. Cary, Harry Darlington, Marion Crary Ingersoll, J. P. Martin, S. Stanwood Menken, Francis F. Randolph, and Chester T. Reed; The Misses Lillie H. Harper, Martha M. Ottley, Margaret Scovill, Edith Hamilton White, and Emily B. Wilson; Doctors John C. A. Gerster, Curtenius Gillette, and Seth M. Milliken; Messrs. Lindsay C. Amos, Geo. De Forest Barton, James M. Brown, Robert J. Bulkley, Merrel P. Callaway, H. J. Cook, G. A. Cormack, Merton L. Cush-

MAN, EDWARD J. DAVEY, HARRY C. DAWKINS, ABRAM I. ELKUS, S. A. EVERITT, WALTER S. FRANKLIN, KARL T. FREDERICK, HALSTEAD G. FREEMAN, HOWARD S. GANS, WM. B. GIVEN, JR., CHARLES V. GRAHAM, PRENTISS N. GRAY, ASHLEY C. HEWITT, ROSCOE C. INGALLS, T. CATESBY JONES, GORDON LEAVITT, ALLEN L. LINDLEY, JOHN B. MARSH, B. B. MCALPIN, WARD MELVILLE, HENRY MEIGS POPHAM, L. S. POSNER, LEON W. ROSENTHAL, HOWARD J. SACHS, WHARTON SINKLER, JR., JOHN C. THORN, JOHN TOD, HAROLD L. WALTON, AND G. ARTHUR WOBIE; THE CALHOUN SCHOOL.

Associate Members: MESDAMES DONALD P. ABBOTT, HAROLD AMORY, DENNY BRERETON, FRANK C. ERVIN, H. H. FAIR, RAYMOND E. LEE, AND GEORGE A. PLIMPTON; THE MISSES LILLY G. PERKINS, SARA PALMAR SHELDON, AND MARION WENRICH; MAJOR S. B. BUCKNER, JR.; DOCTORS THOMAS J. LEBLANC AND H. N. TORREY; MESSRS. IVERS S. ADAMS, A. B. ARVIDSON, WEBB R. BALLORD, CHAS. N. BLACK, R. A. BRAY, PHILIP DALTON, E. R. DIMOND, JOHN S. EDWARDS, GEOFFREY W. ESTY, EVAN C. EVANS, SR., JOHN ALLEN FULTON, U. S. GRANT, 4TH., KENNETH GREGORY, LAWRENCE D. HIETT, WILLIAM GORDON HITCHCOCK, CLARENCE A. HORN, SEYMOUR H. KNOX, HARRY H. LARKIN, G. HENRY F. MARTINEZ, O. C. MCBRIDE, A. LESLIE OLIVER, E. B. POWERS, DELANCEY RANKINE, PAUL H. SANGREE, J. H. SMITH, F. W. STAEBNER, DANIEL W. STREETER, JAMES D. TEW, PHILIP W. TOMPKINS, GEORGE UPTON, JR., AND ALBERT F. W. VICK.